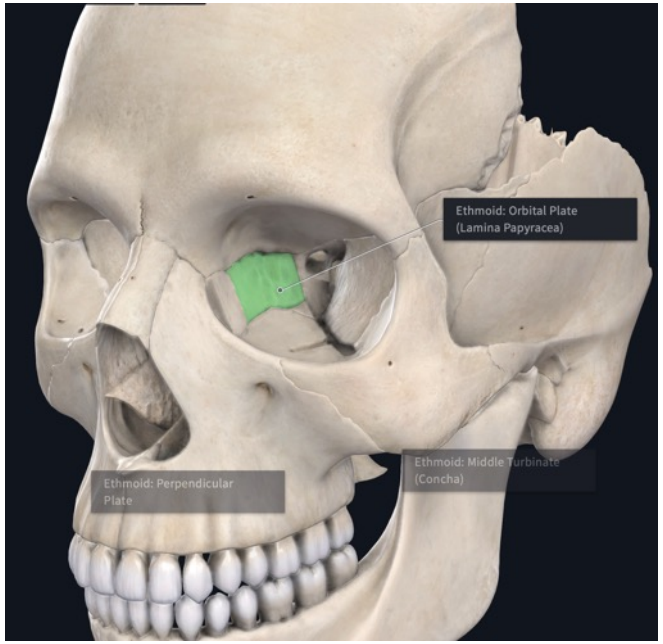
MBB Lab 5, Part B: PowerPoint Handout
Skull Osteology

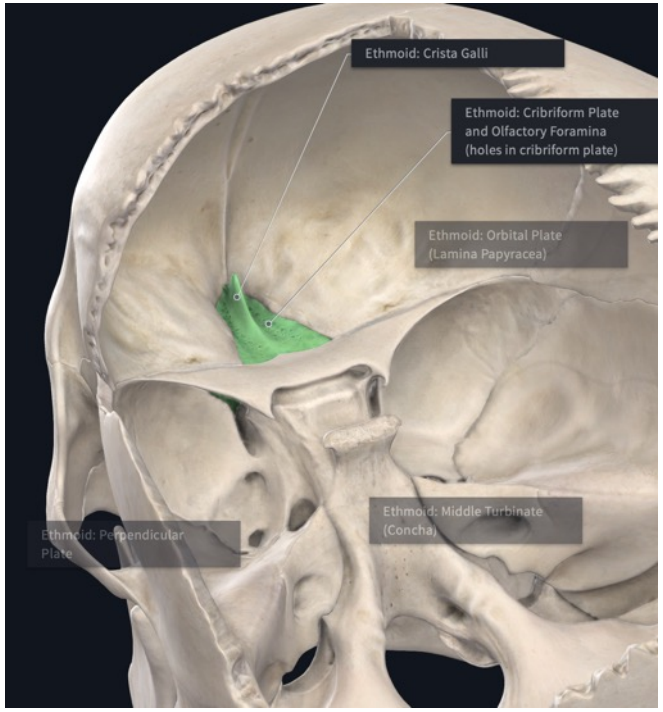
- This is a comprehensive guide of all the skull features you must know by the practical exam.
- Many of these structures will be presented multiple times during upcoming labs.
- This PowerPoint Handout is the resource you will use during lab when you have access to skulls.

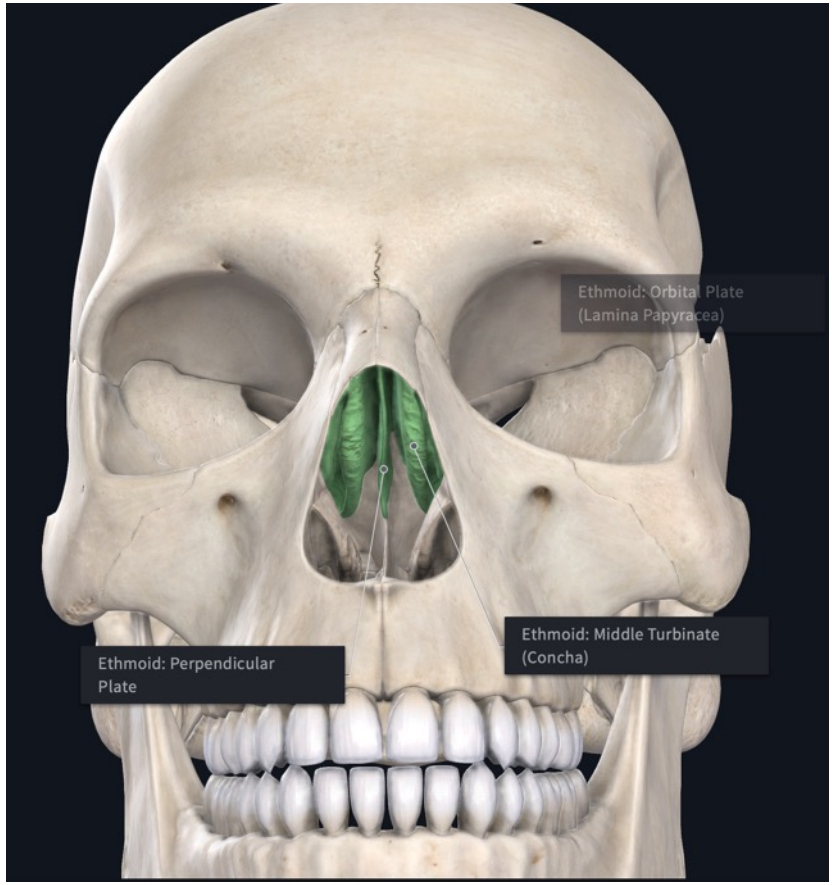
Osteology of the Skull

Ethmoid

- Cribriform plate/foramina (olfactory nerves)
- Crista galli
- Perpendicular plate
- Superior turbinate (concha) and meatus
- Middle turbinate (concha) and meatus
- Orbital plate (lamina papyracea)







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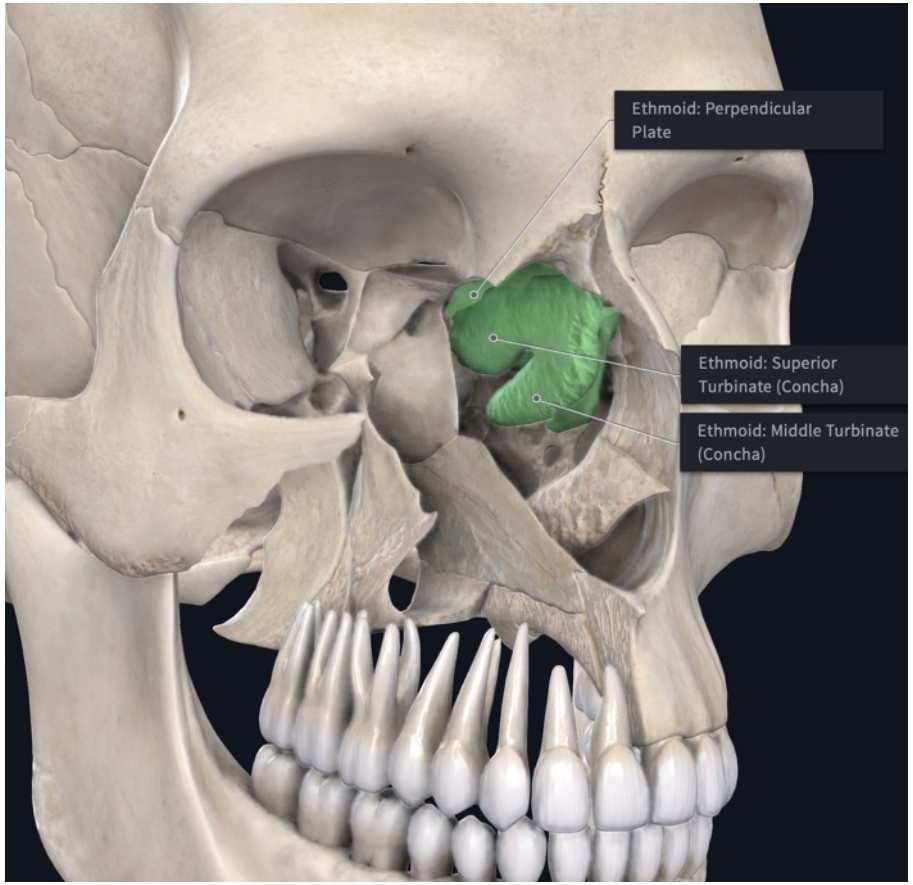

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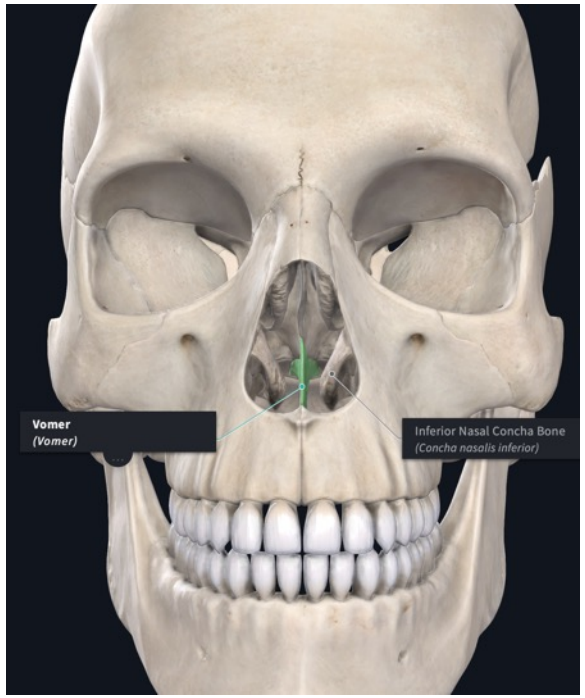
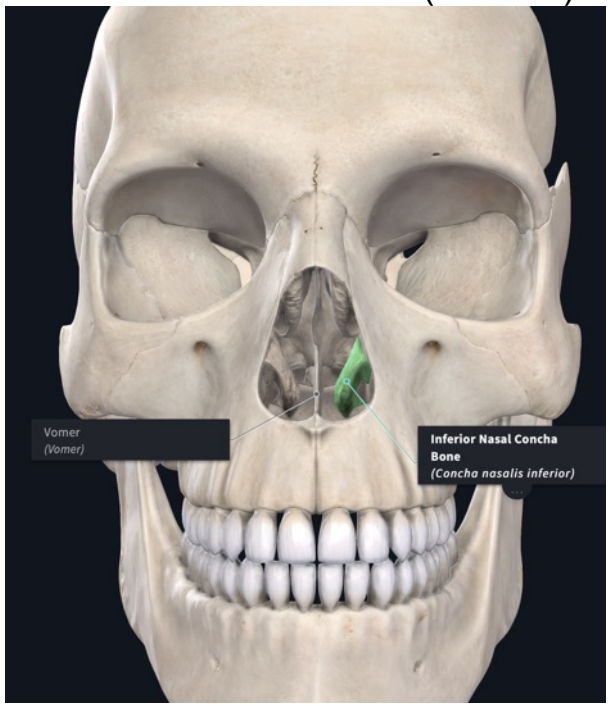
Vomer, Nasal Bone, and Inferior Turbinate (Concha)

Vomer



Inferior Nasal Turbinate (Concha)



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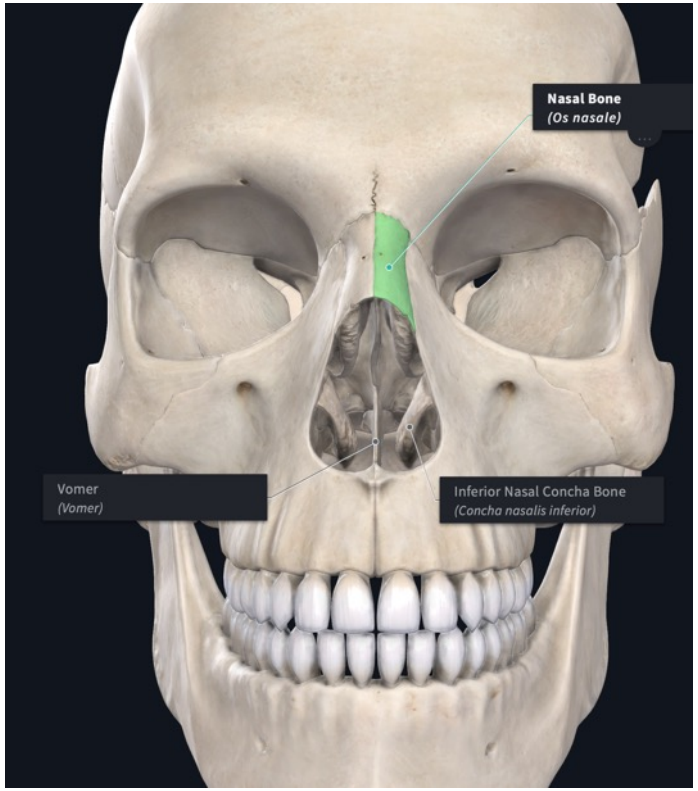
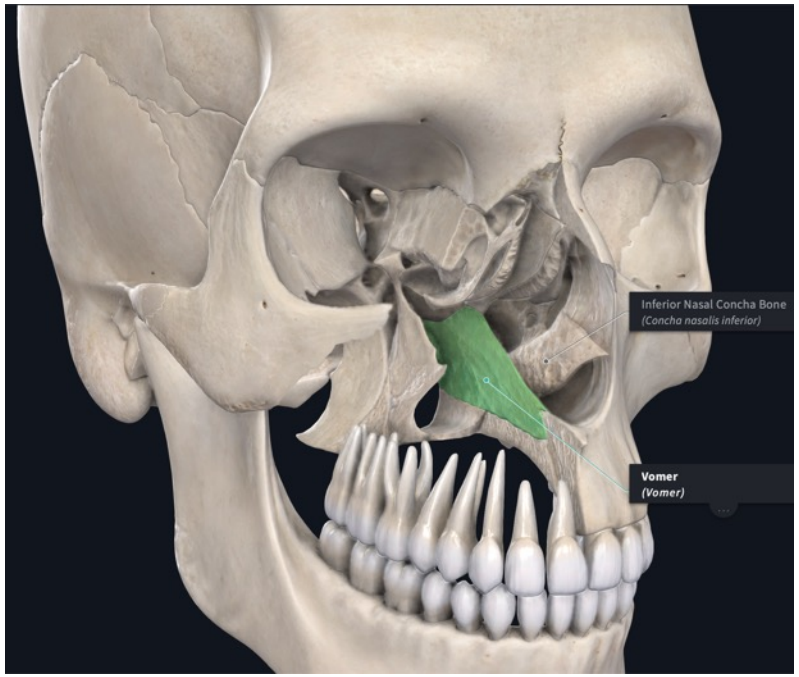
Nasal Bone





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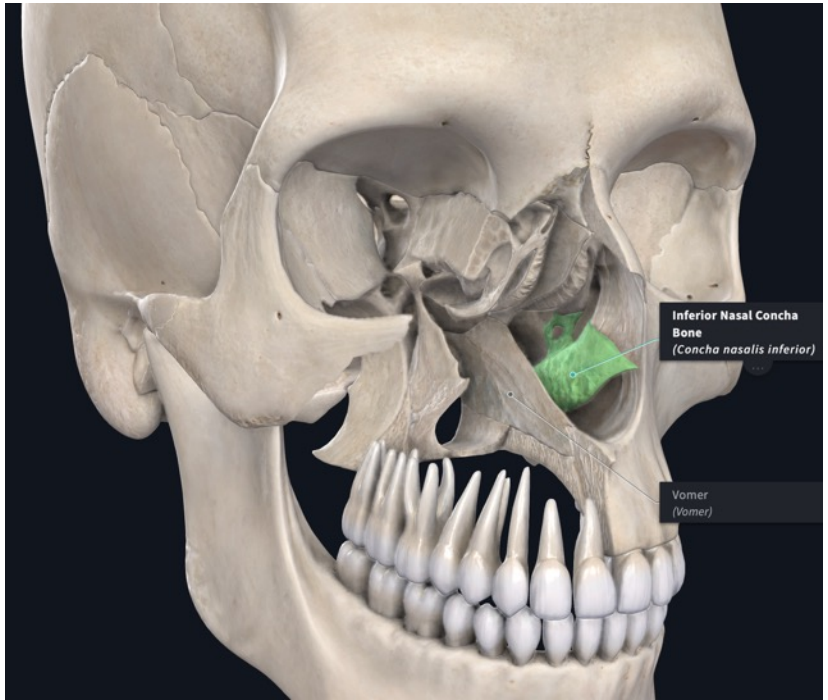
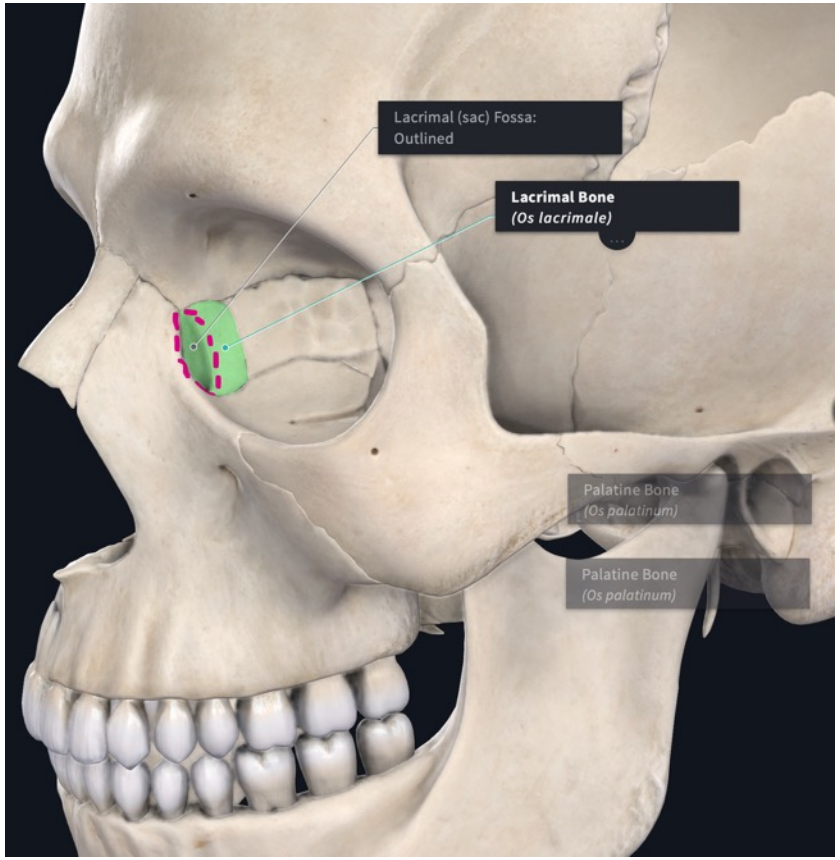
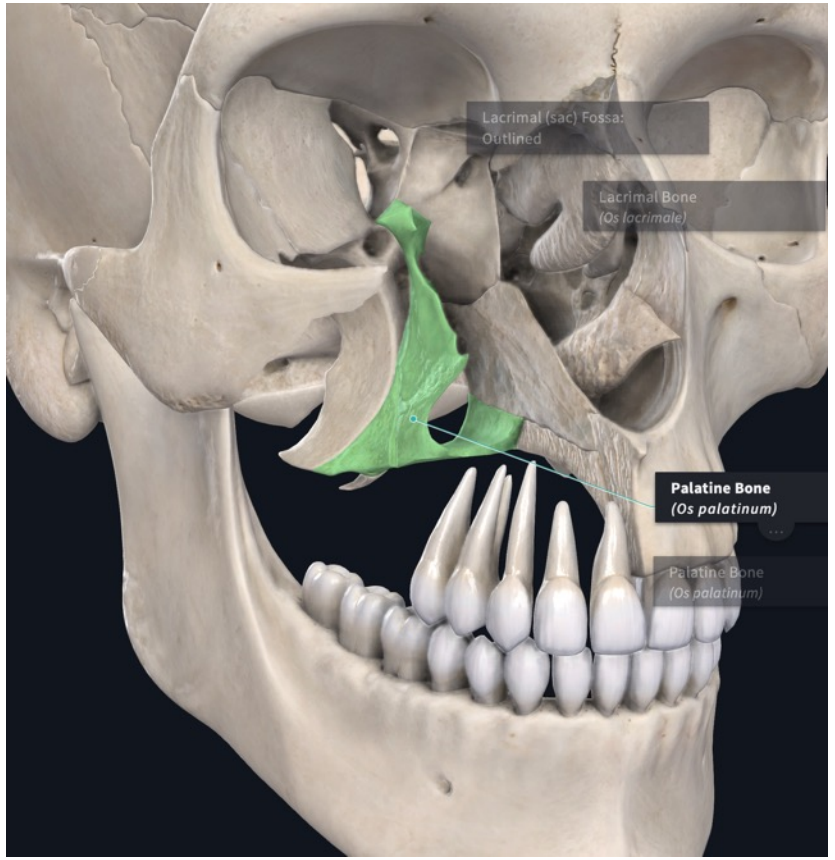


Lacrimal and Palatine Bones

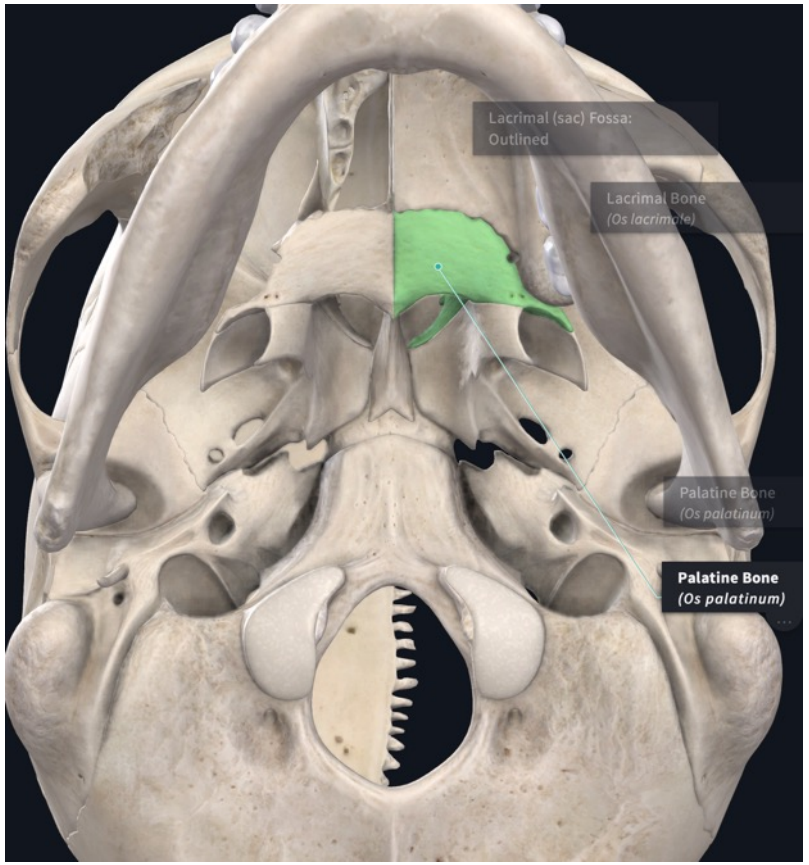
- Lacrimal Bone
- Lacrimal (Sac) Fossa



- Palatine Bone (Maxilla Removed)



- Palatine Bone (Inferior view forming a portion of the hard palate)



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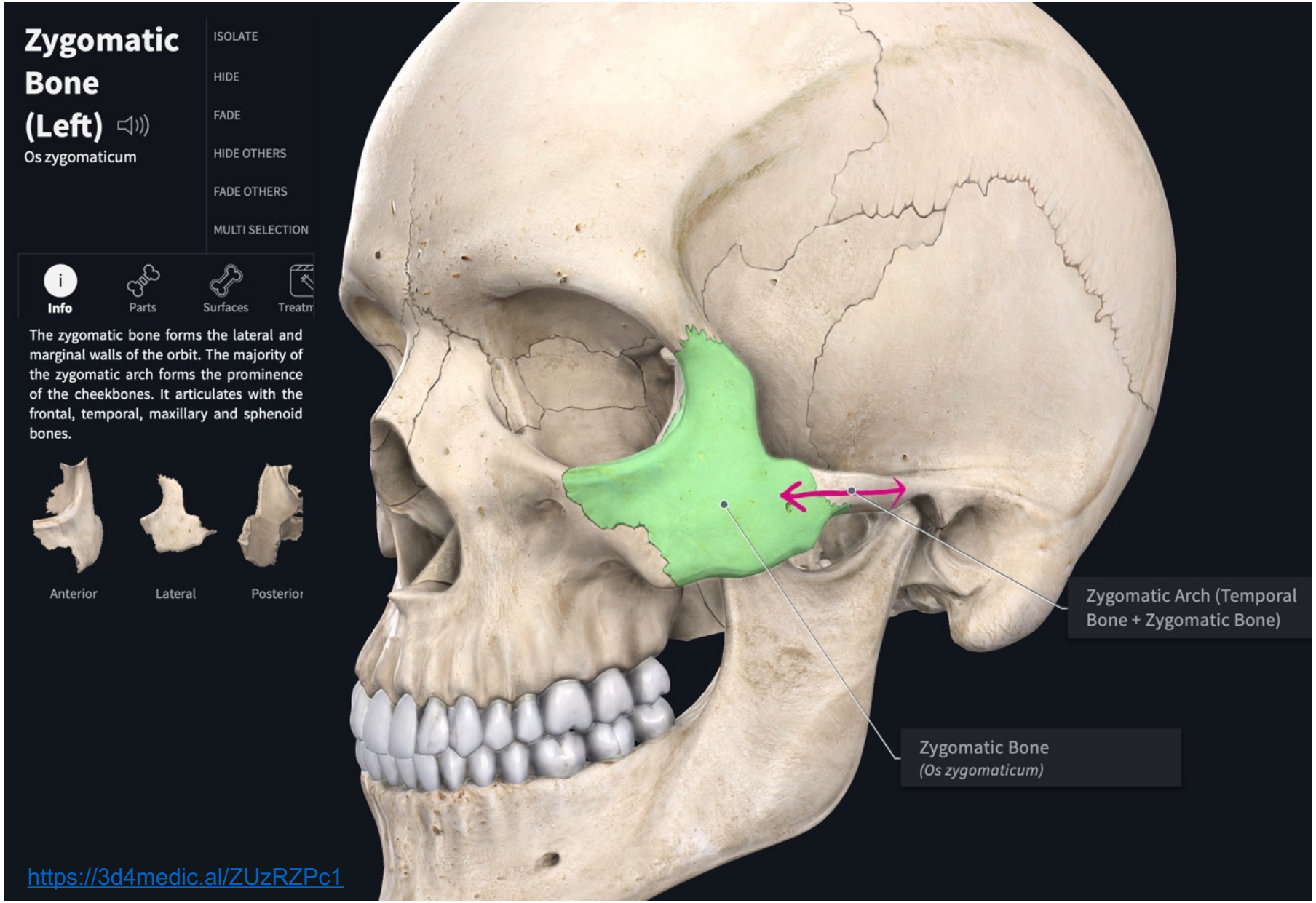
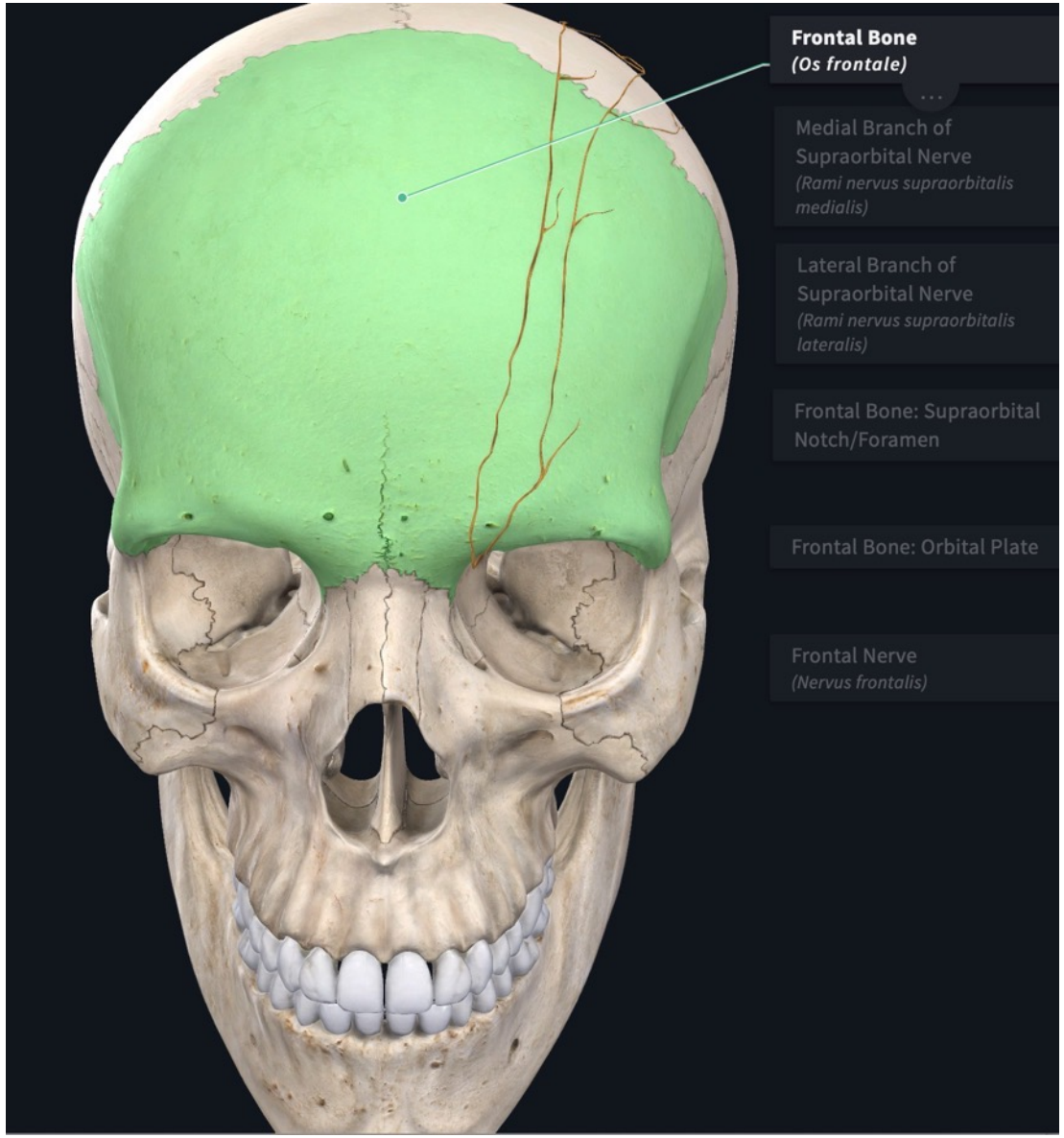
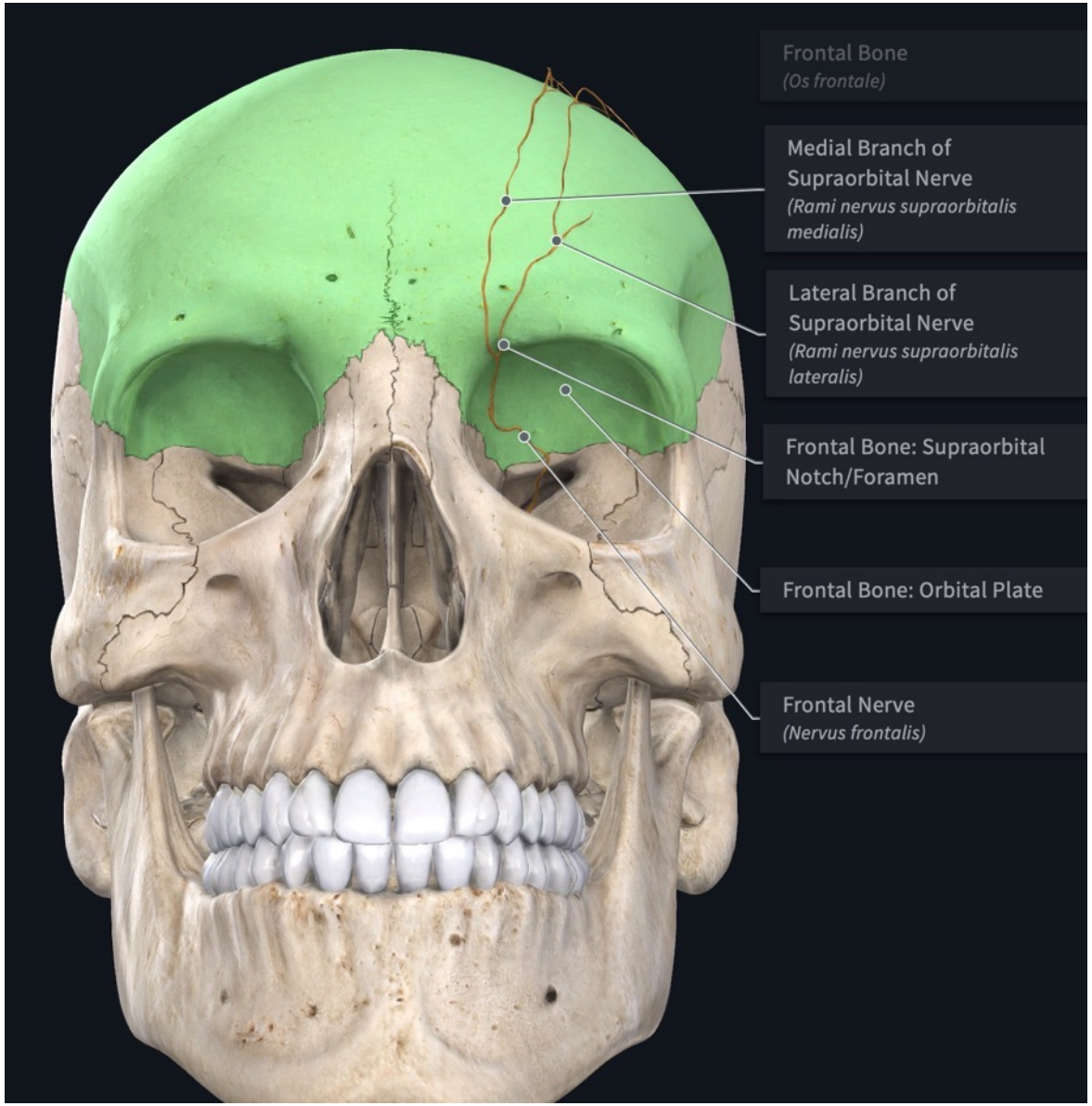
Zygomatic Bone



Frontal Bone

- Supra-orbital notch/foramen (supraorbital nerve)
- Orbital plate





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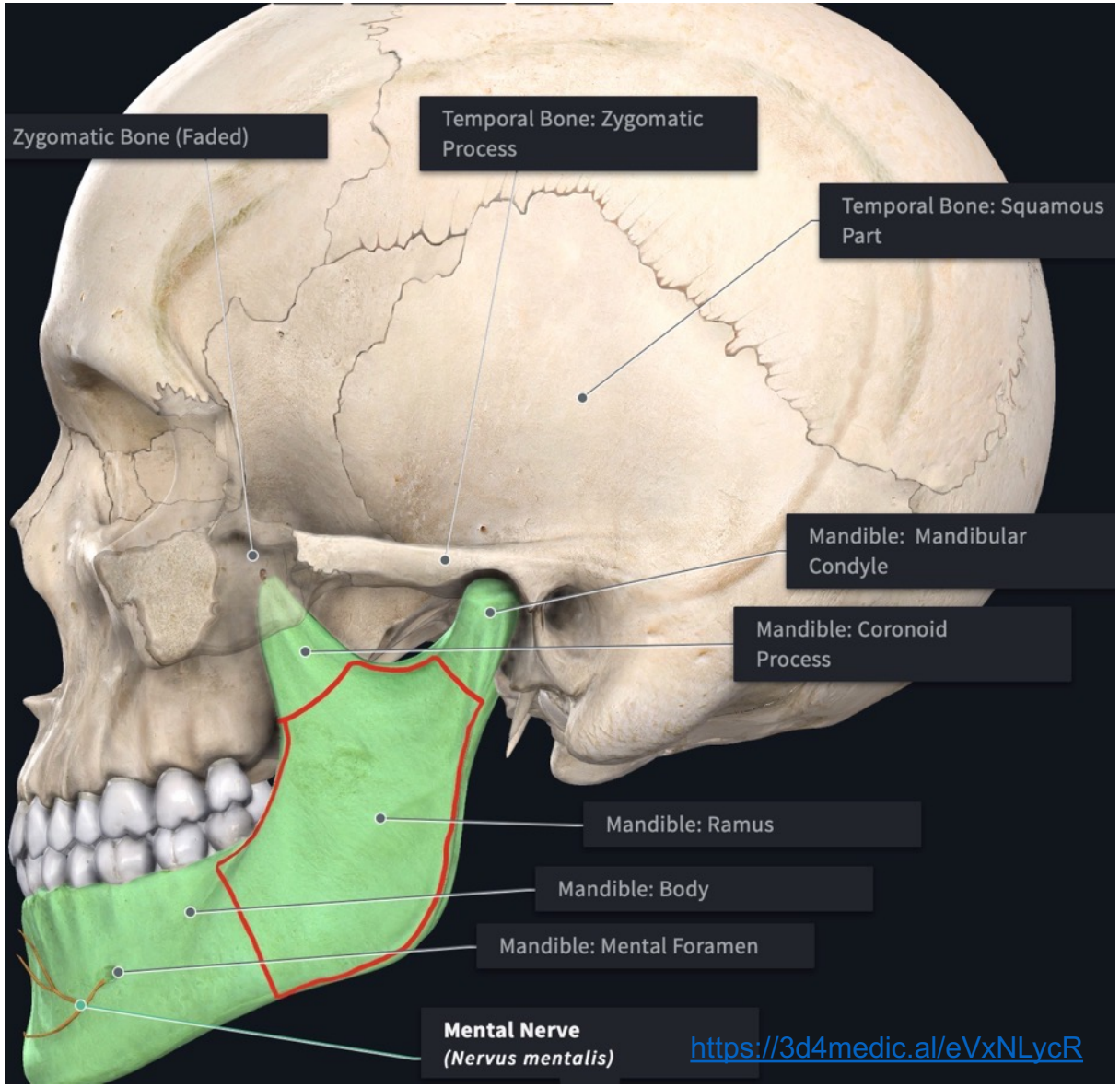
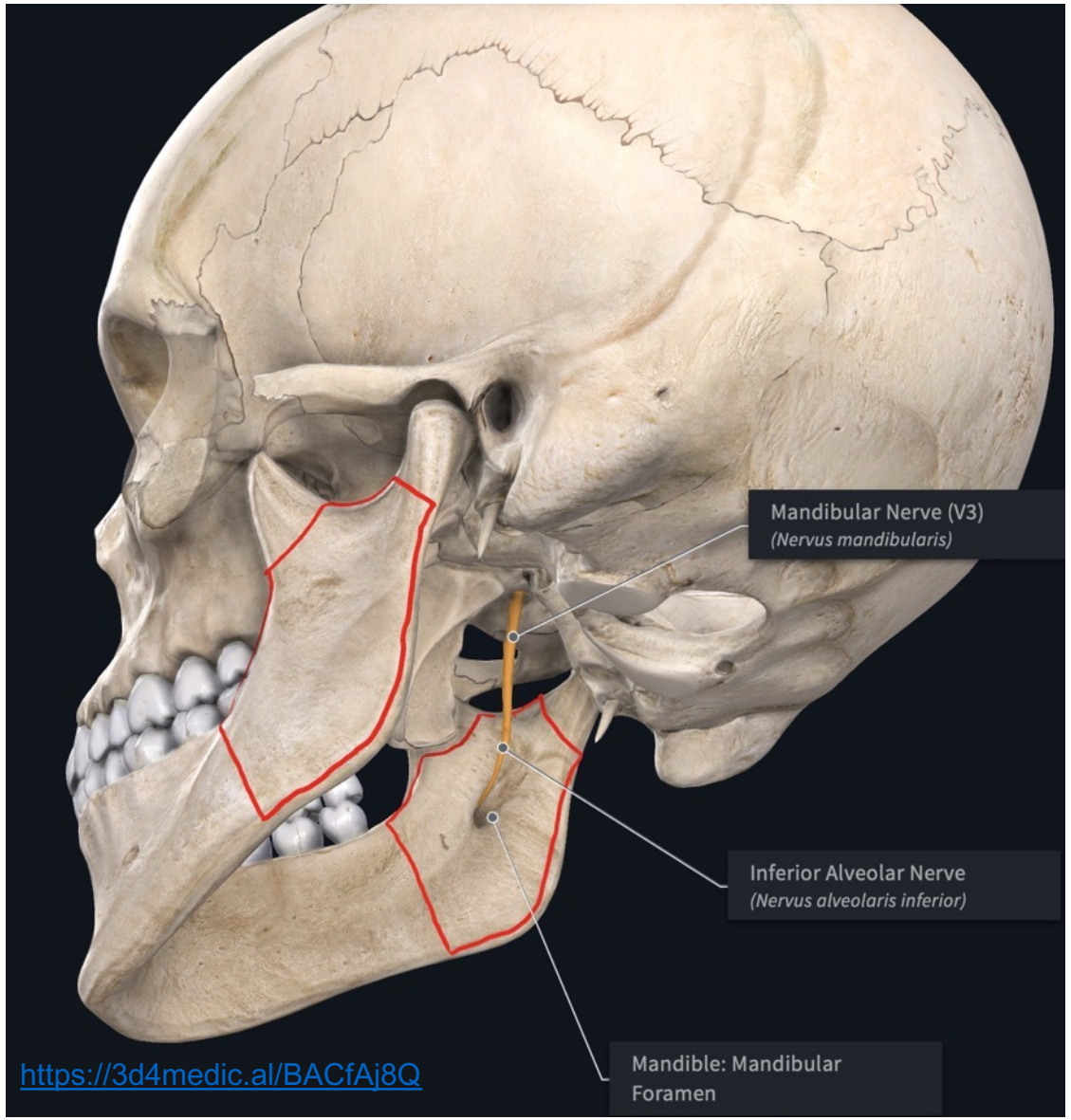
Mandible

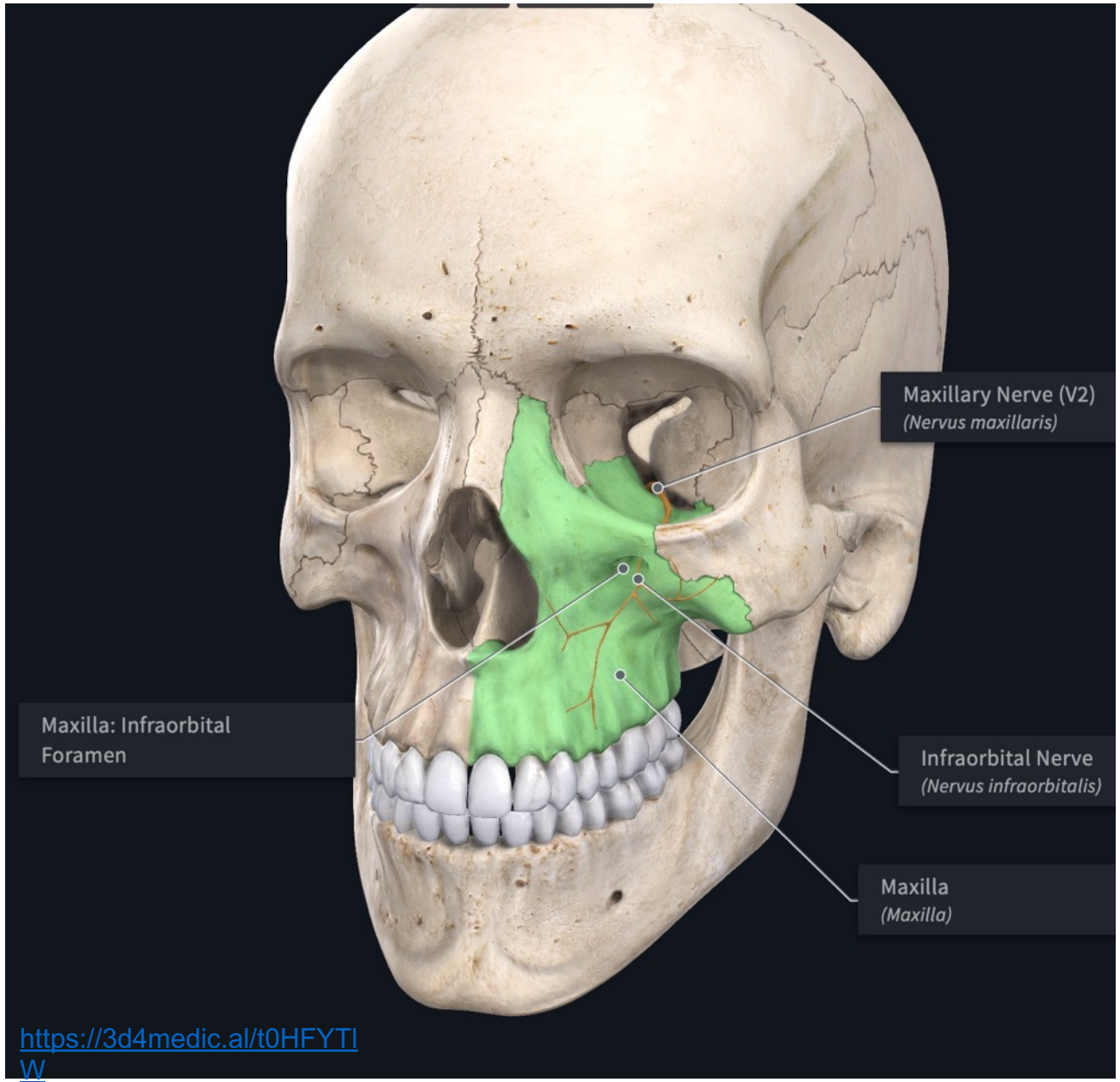
- Body
- Mandibular Condyle
- Ramus
- Coronoid process
- Mental foramen (Mental nerve branch of inferior alveolar nerve)
- Mandibular foramen (Inferior alveolar nerve branch of mandibular nerve)





Maxilla

- Infra-orbital foramen (Infraorbital nerve branch of maxillary nerve)



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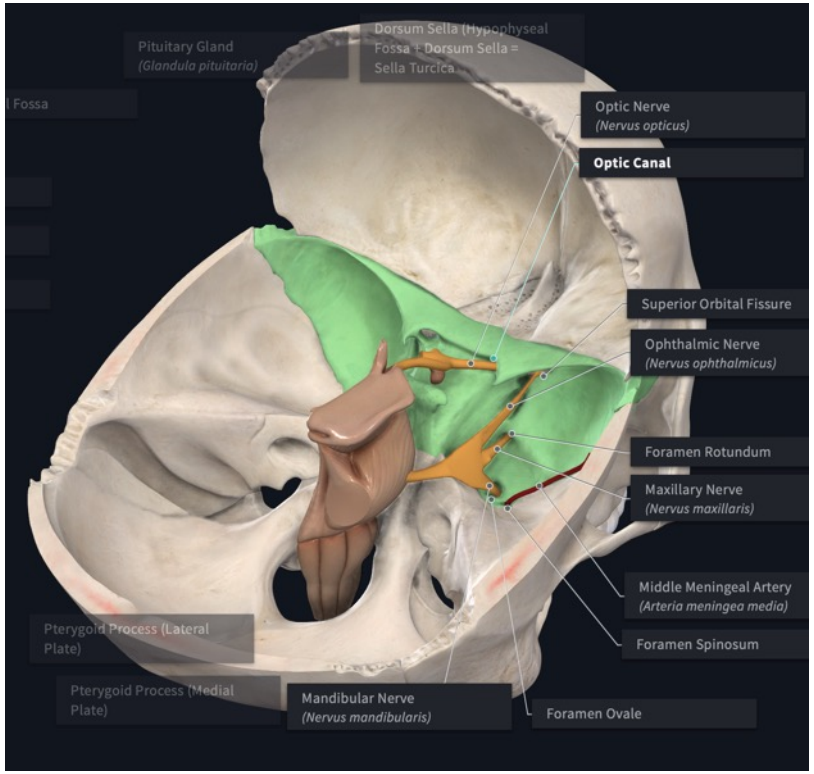
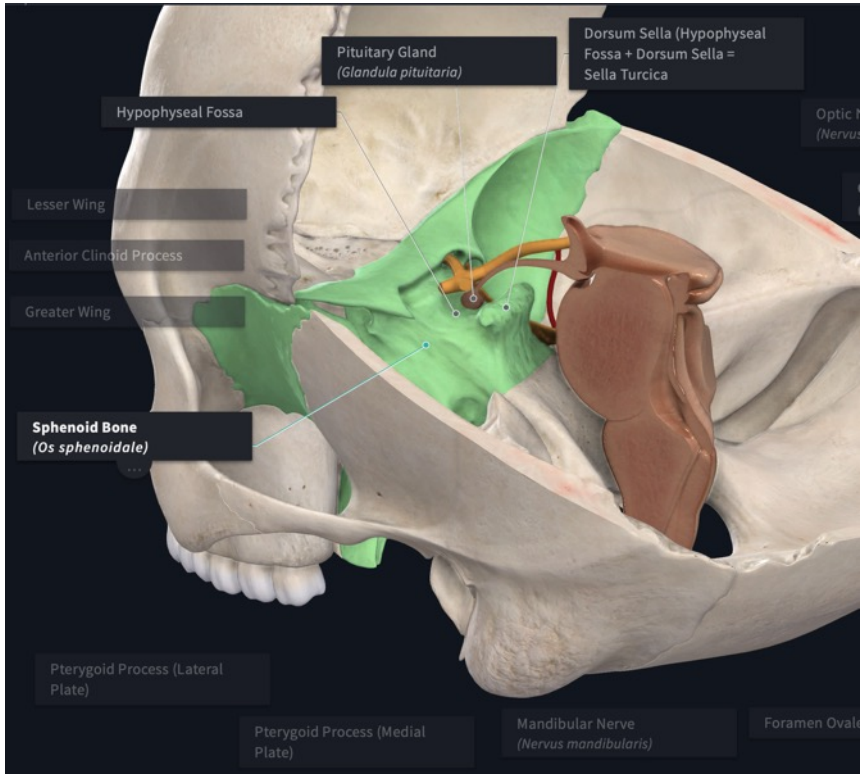
Sphenoid Bone

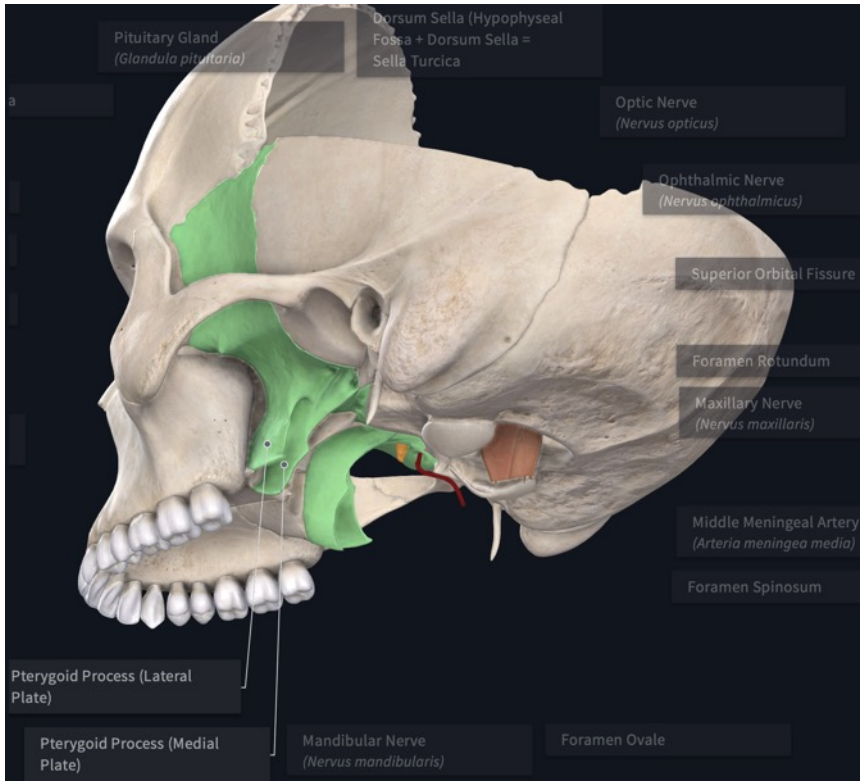
- Superior orbital fissure
- Optic canal
- Foramen rotundum
- Foramen spinosum
- Foramen ovale

- Hypophyseal fossa
- Dorsum sellae
- Sella turcica

- Lesser wing
- Pterygoid process
- Anterior clinoid processes







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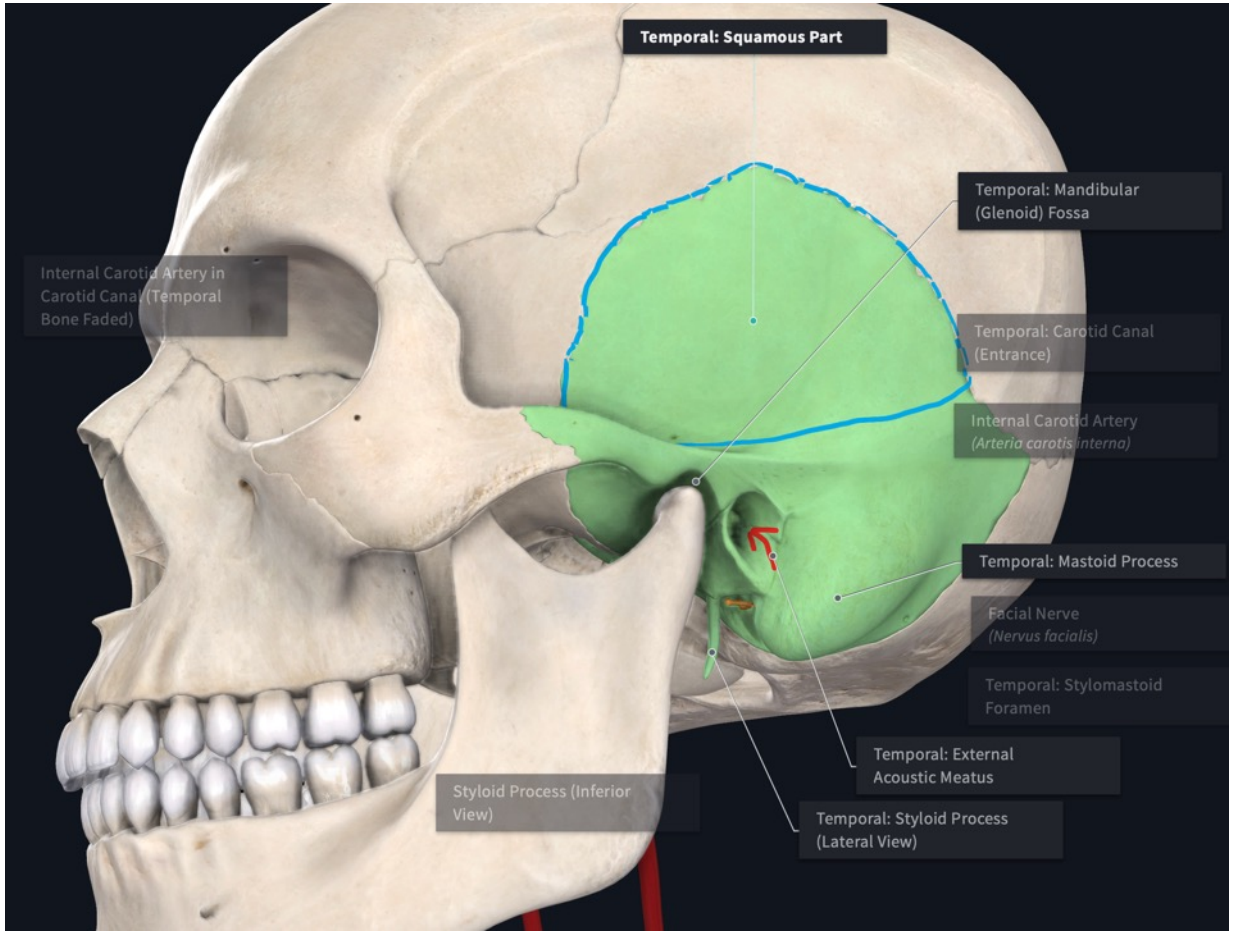
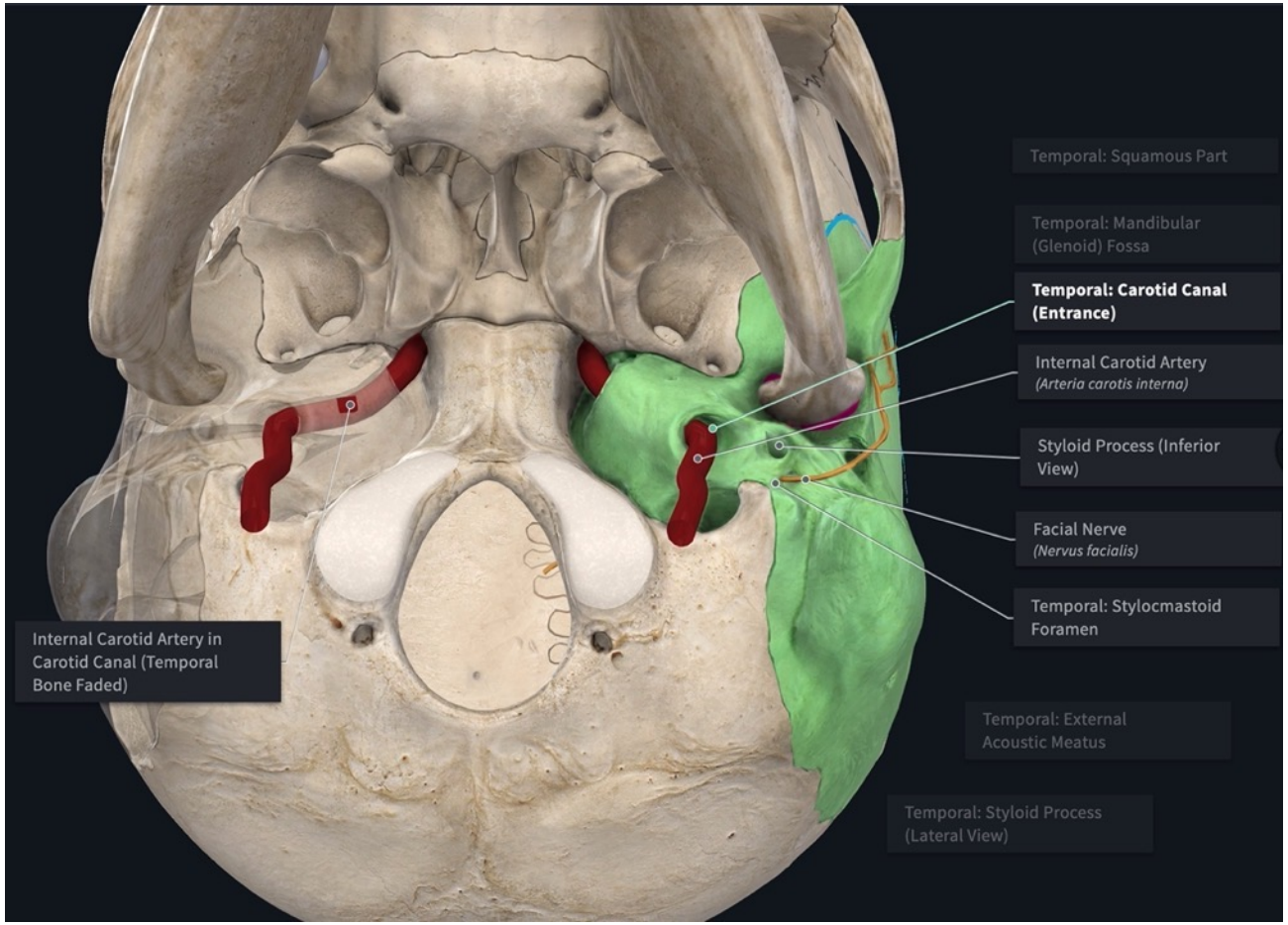
Temporal Bone

- Squamous part
- Styloid process
- Stylomastoid foramen
- Mandibular fossa (glenoid fossa

- Carotid canal
  - Review: [Moyer PRL: Path of Internal Carotid Artery (Panopto)]
- External acoustic meatus
- Mastoid process
- External acoustic meatus





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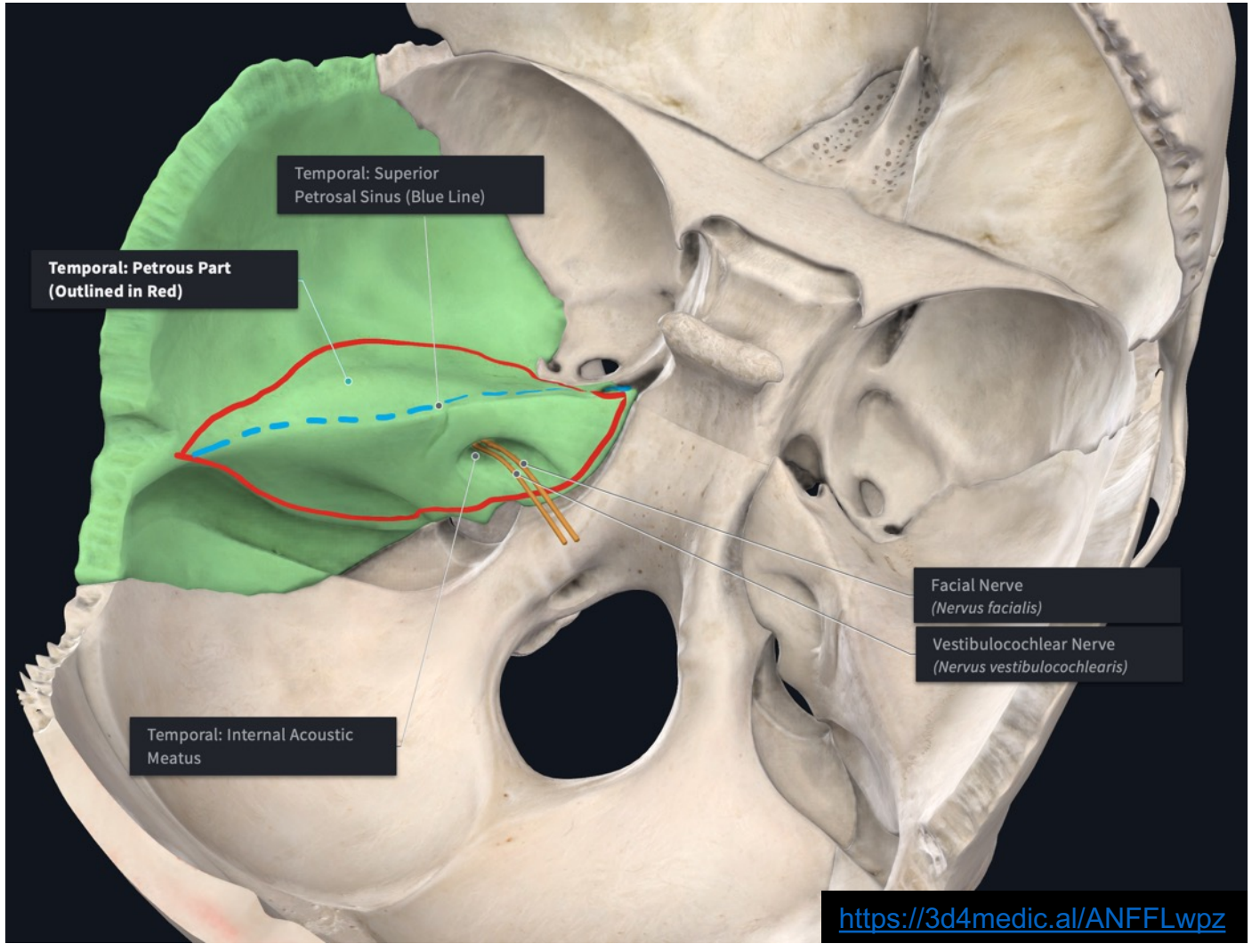
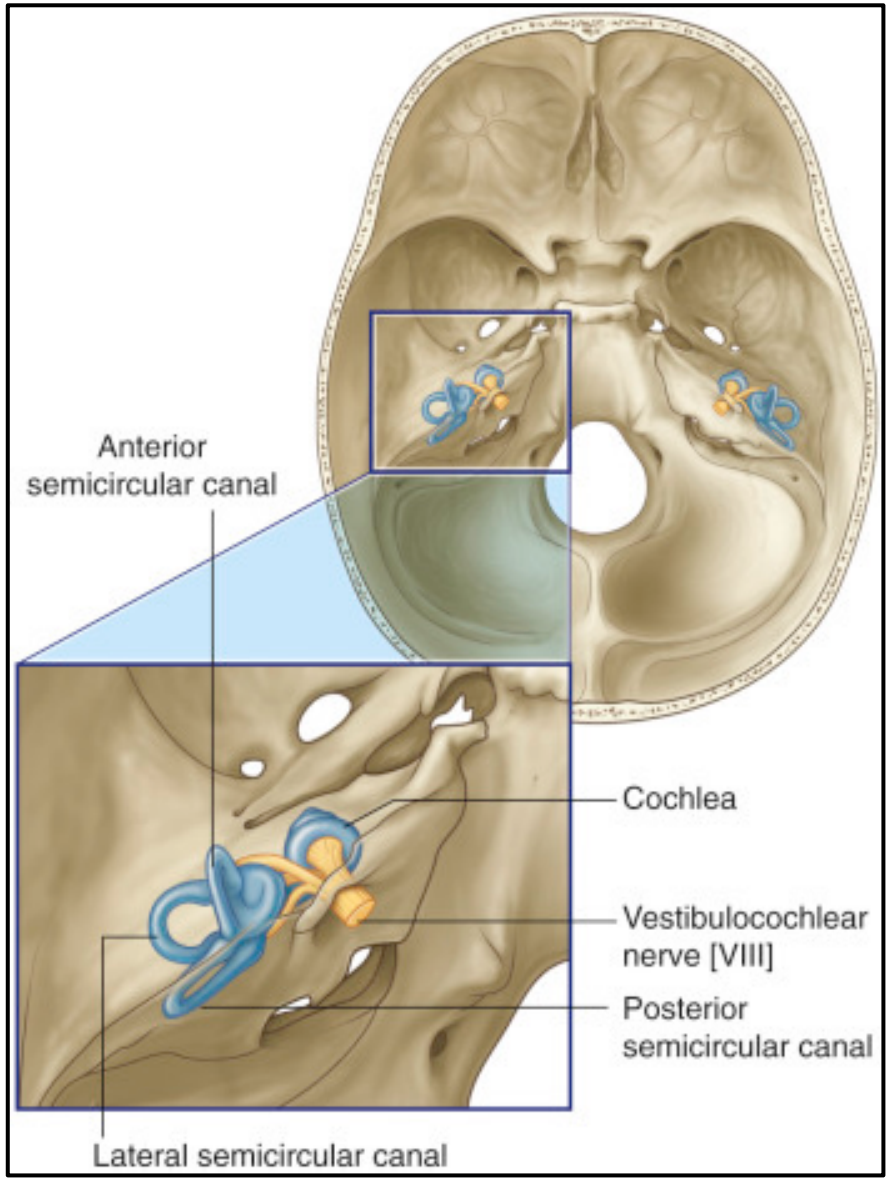
Temporal Bone (Continued)

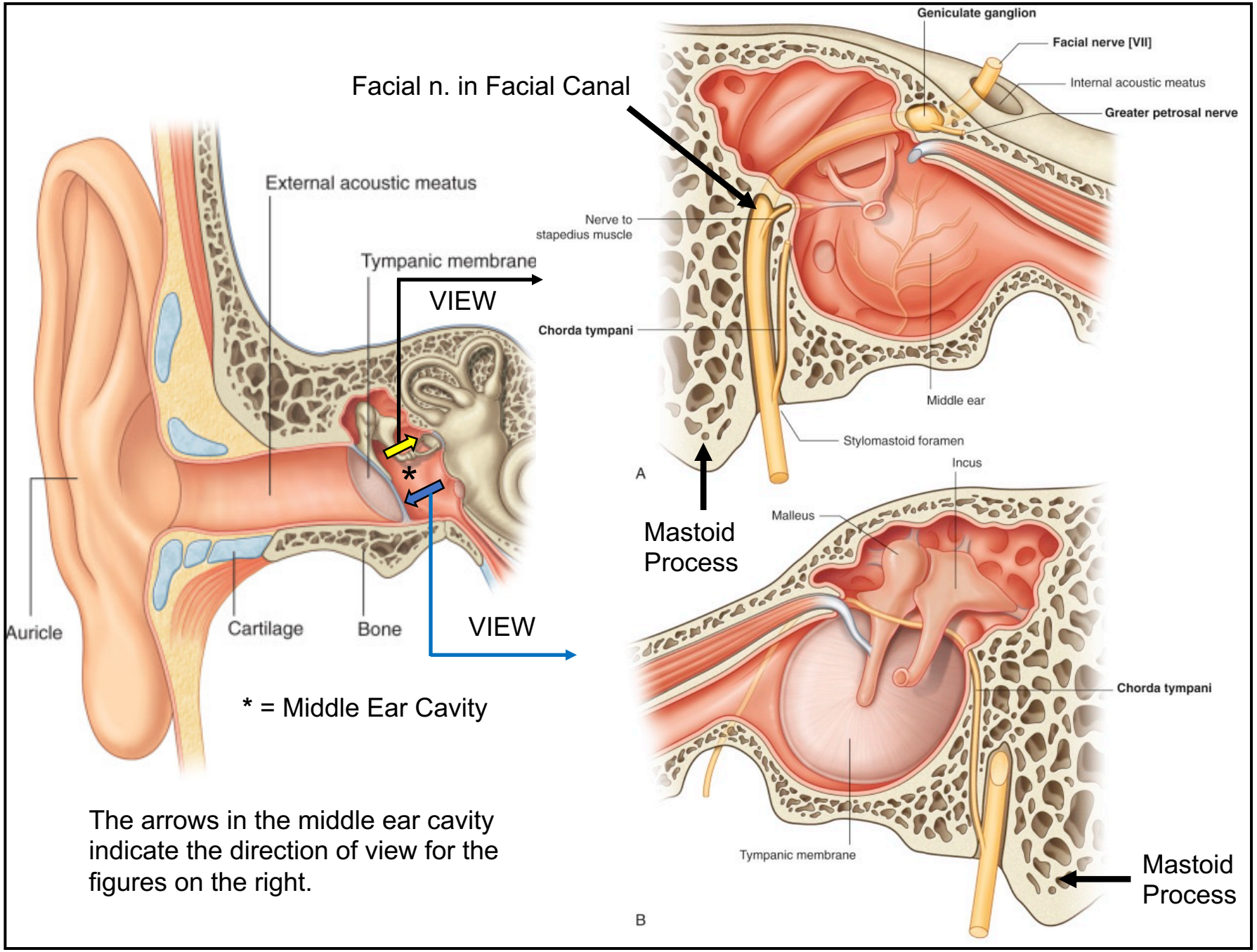
- Petrous part
- Groove for superior petrosal sinus
- Internal acoustic meatus (Facial nerve
- Facial canal (cut bone only or model)
- Middle ear cavity

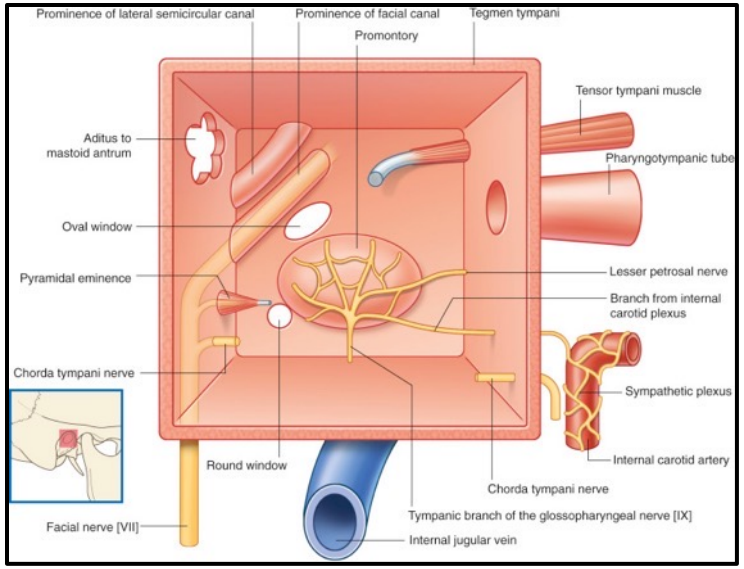




The figure above shows the location of the inner ear components (cochlea, semicircular canals, vestibule) within the petrous portion of the temporal. These structures are located between the middle ear laterally and the internal acoustic meatus medially.

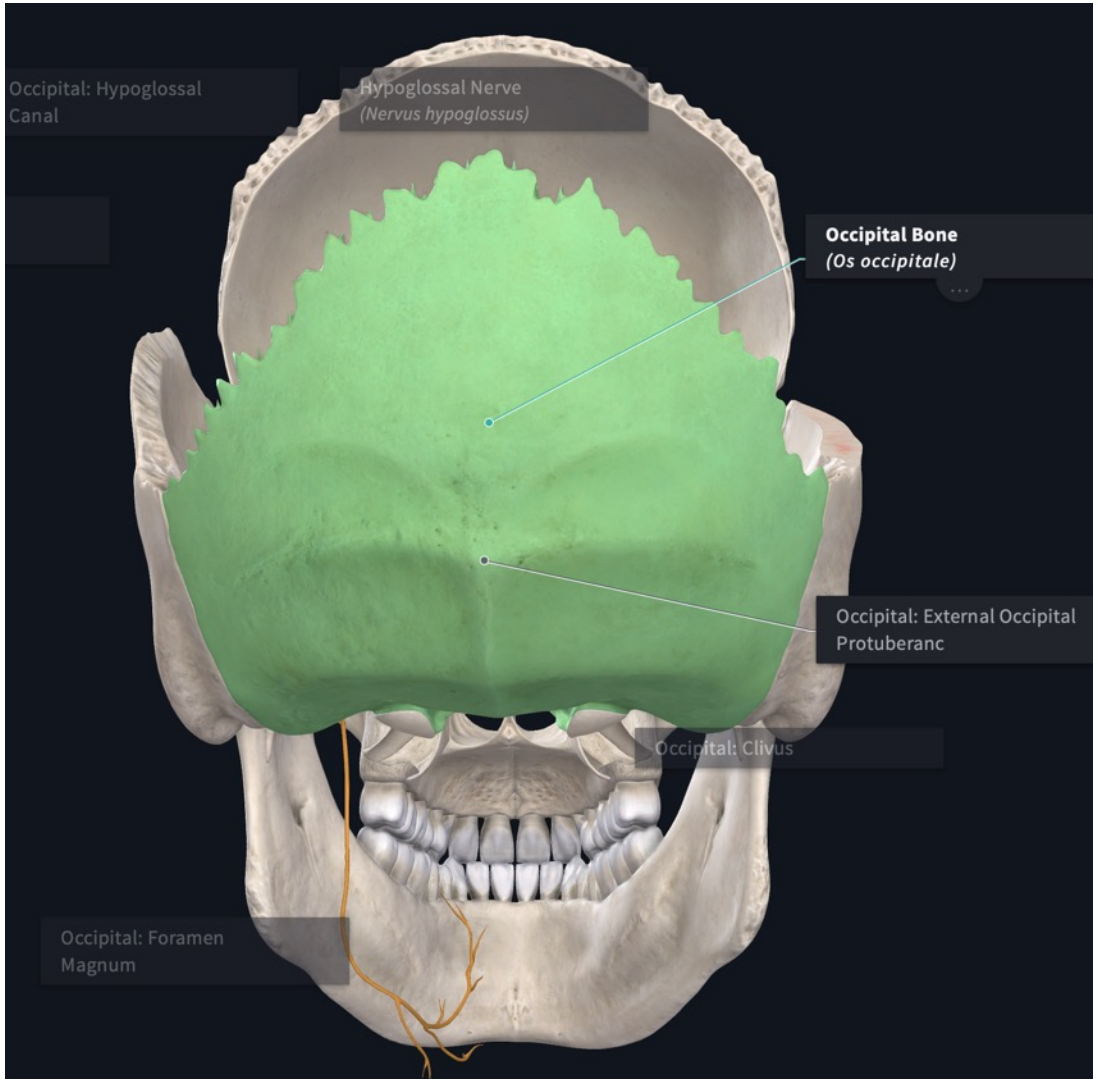
Temporal Bone (Middle Ear Cavity and Facial Canal)

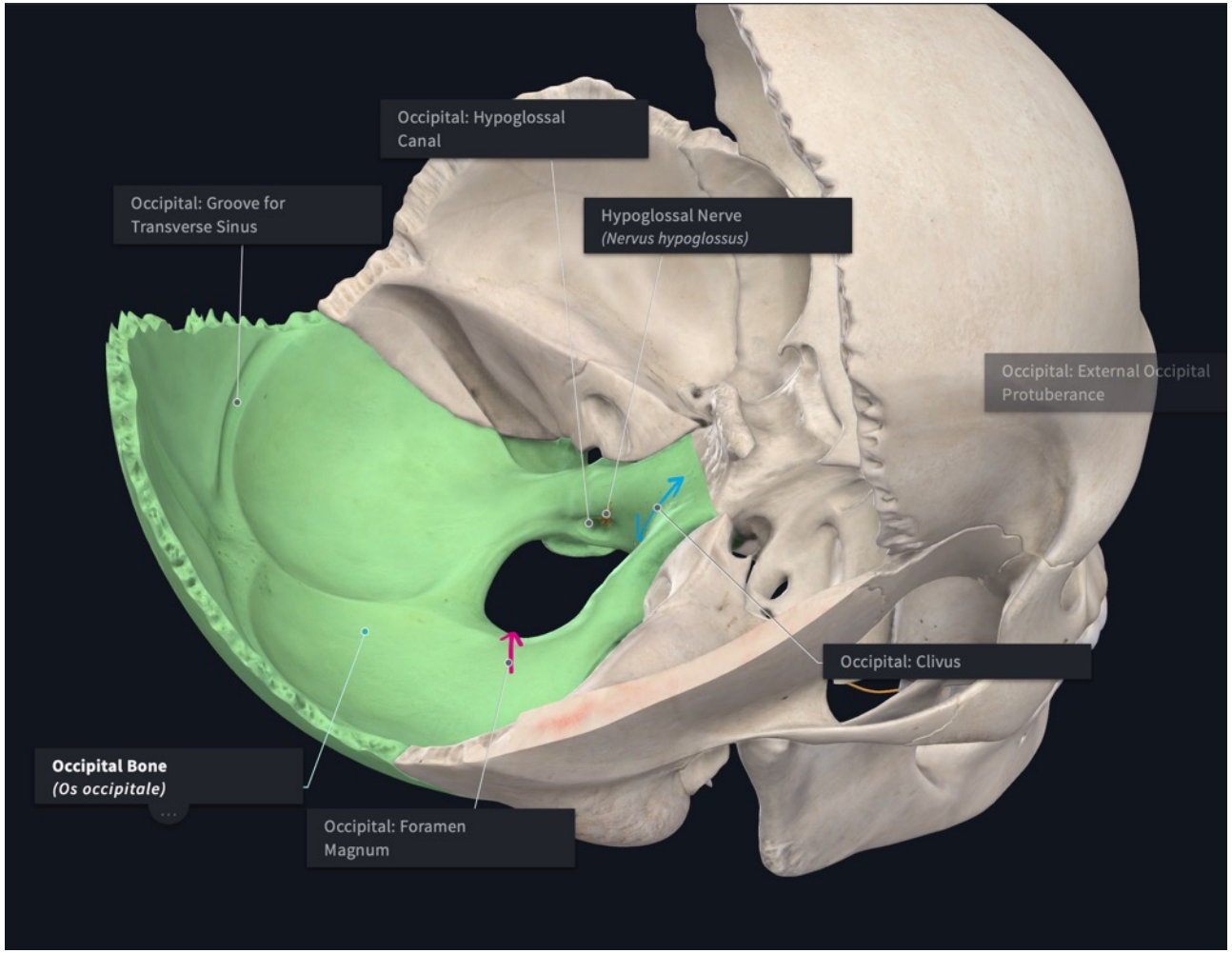




Occipital Bone

- Clivus
- External occipital protuberance
- Groove for transverse sinus
- Foramen magnum
- Hypoglossal canal (hypoglossal nerve)





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Structures/Spaces Formed by More Than One Bone

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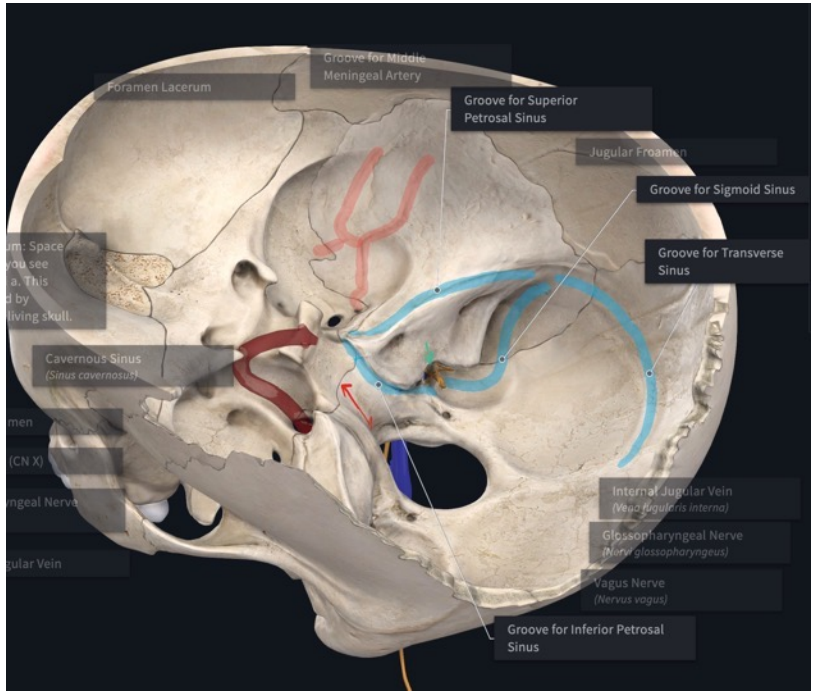
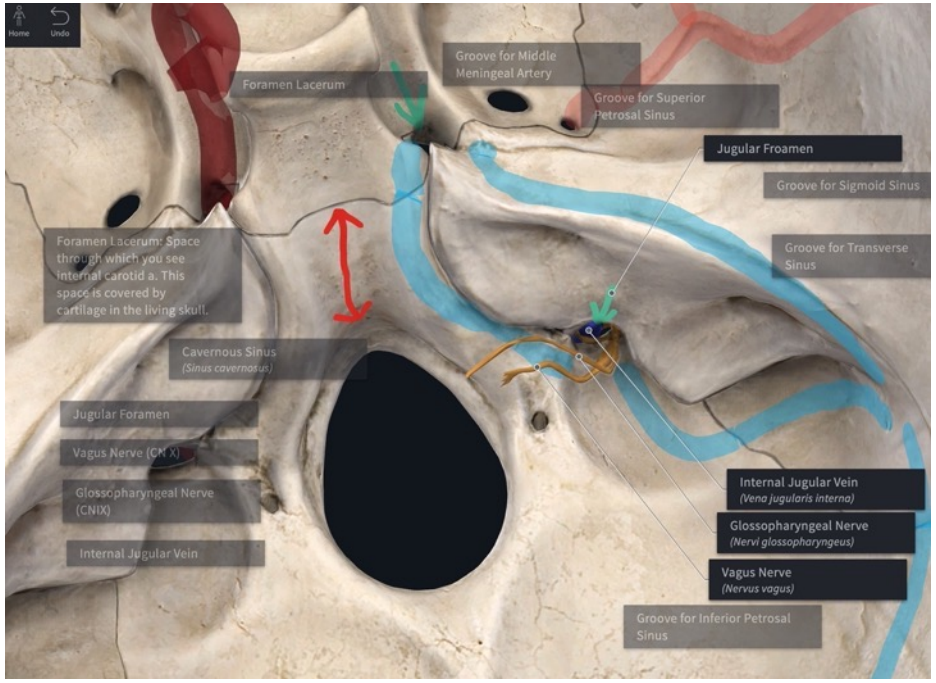
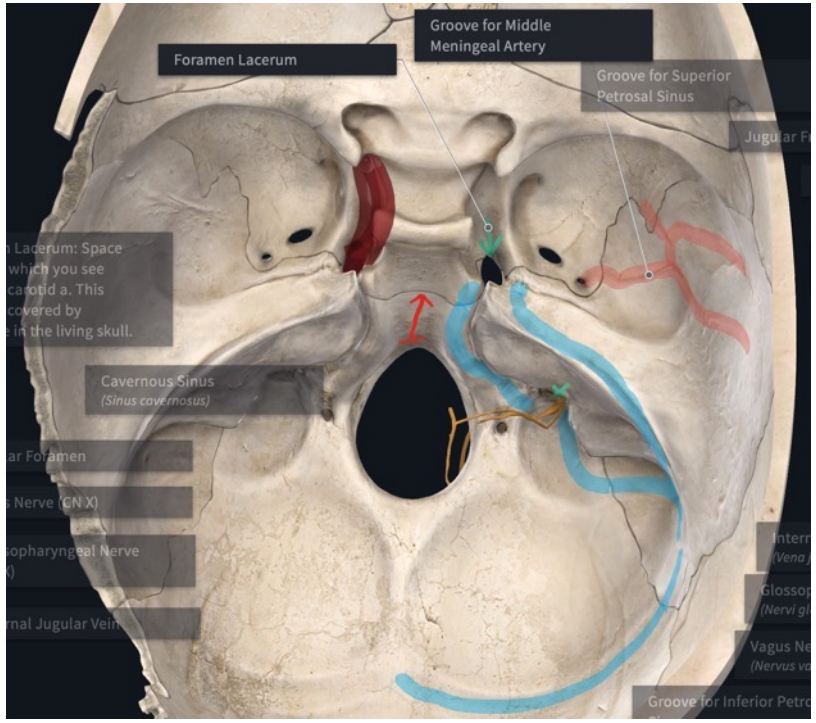
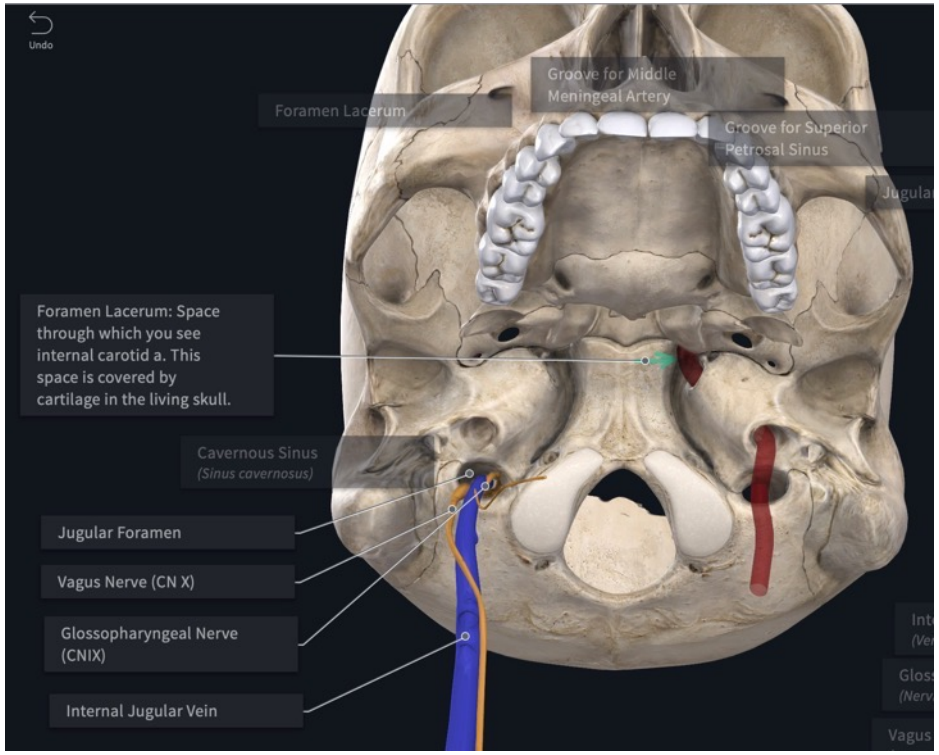
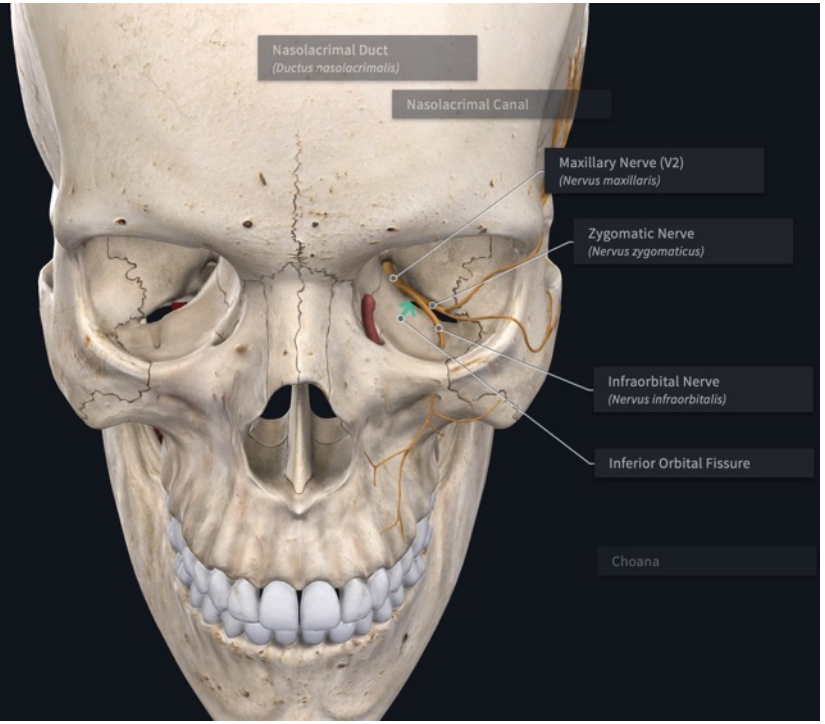


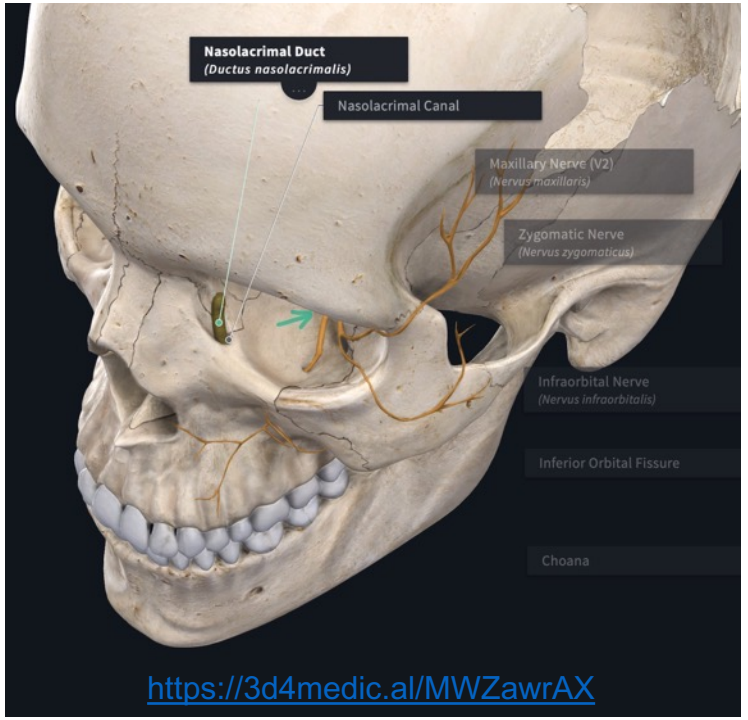






Structures/Apertures Formed by More Than One Bone





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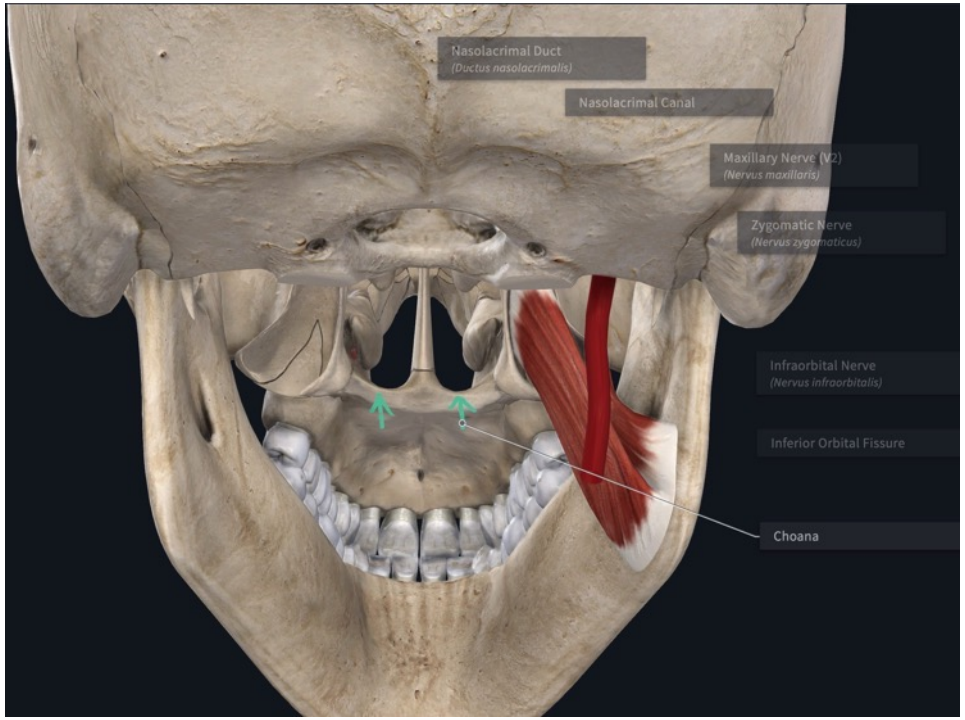
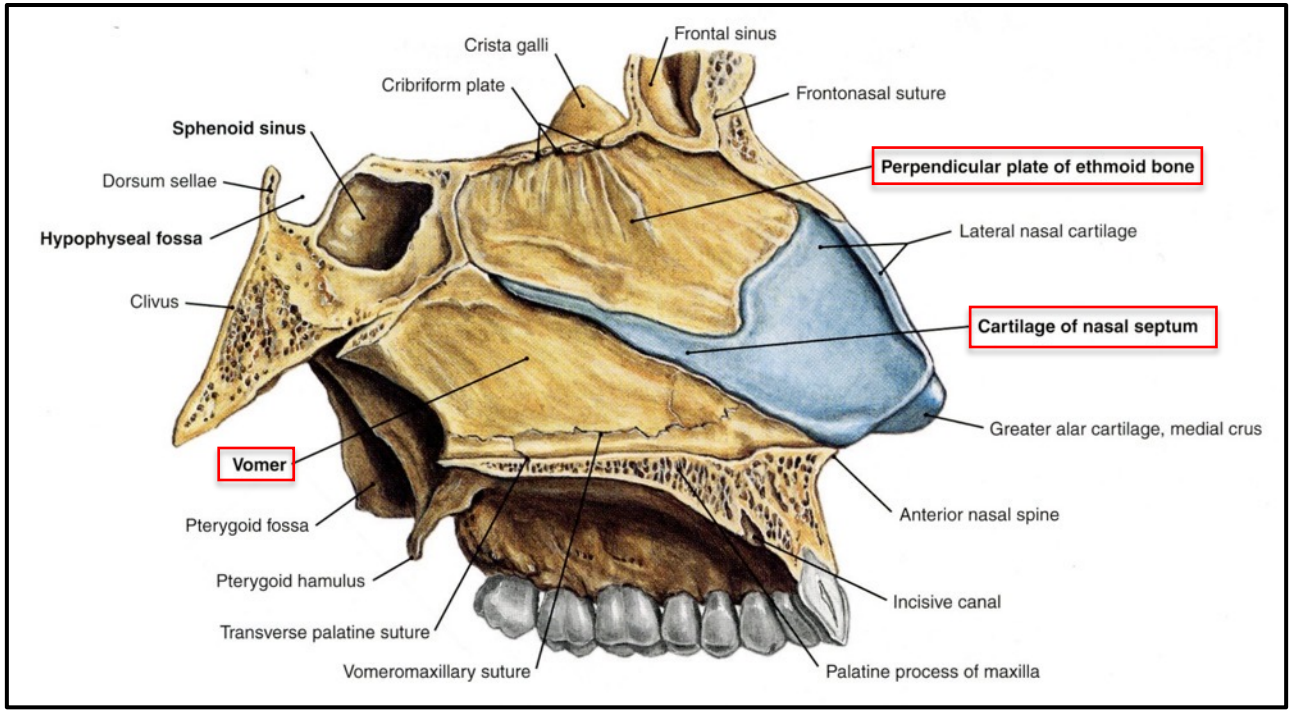
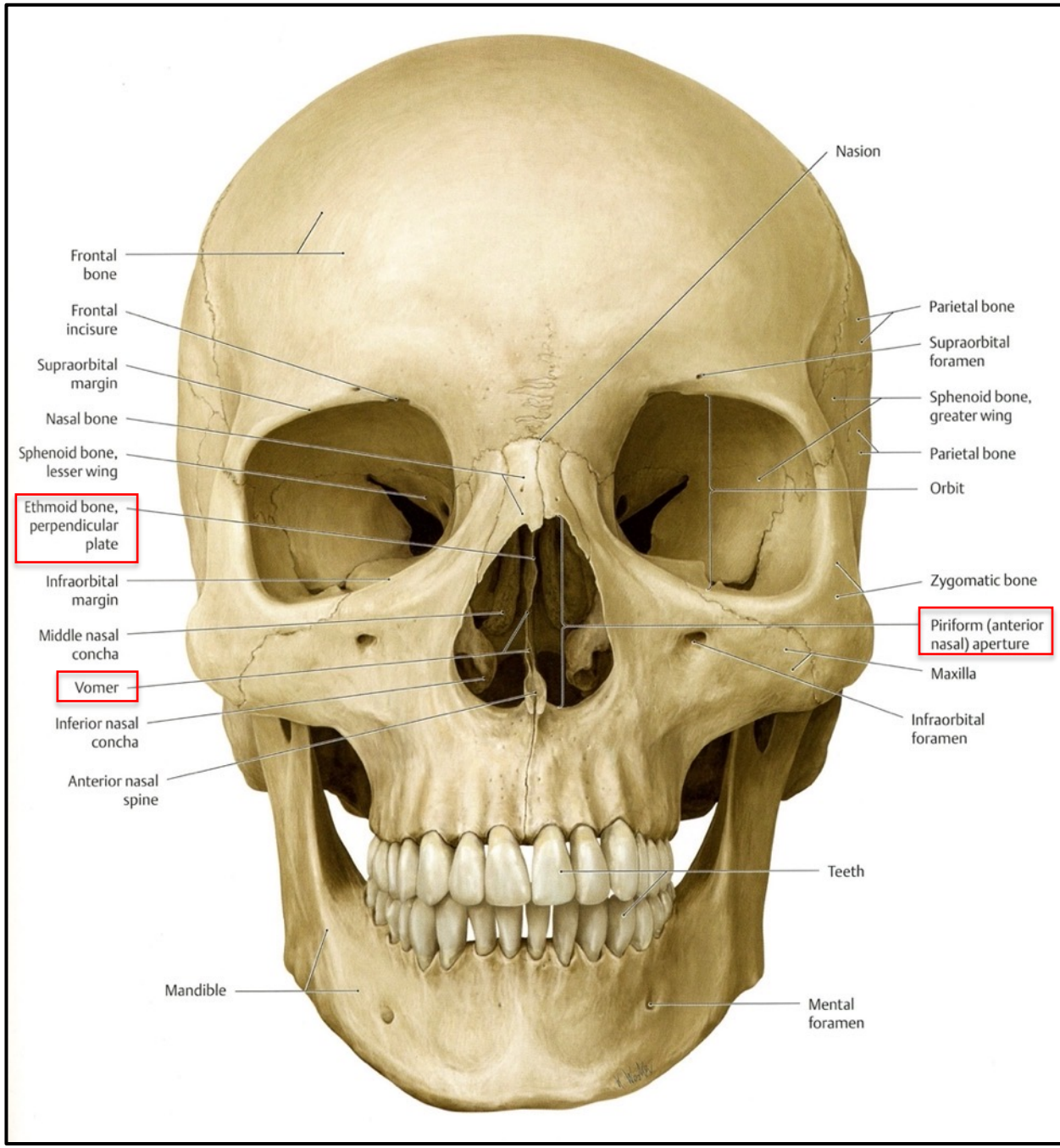


Nasal Septum

- The **nasal (piriform) aperture** is the pear-shaped opening that forms the anterior limit of the nasal skeleton.
- The **nasal cavity** is a space within the skull that is the most superior portion of the respiratory tract. It communicates anteriorly through the **nostrils** and posteriorly with the nasopharynx through osseous openings called **choanae.** The **nasal septum** divides the **nasal cavity** into a right and left side. In a living person, the septum consists of the following structures.
    - **The perpendicular plate of the ethmoid bone**
    - **The vomer bone**
    - **The nasal septum cartilage**.

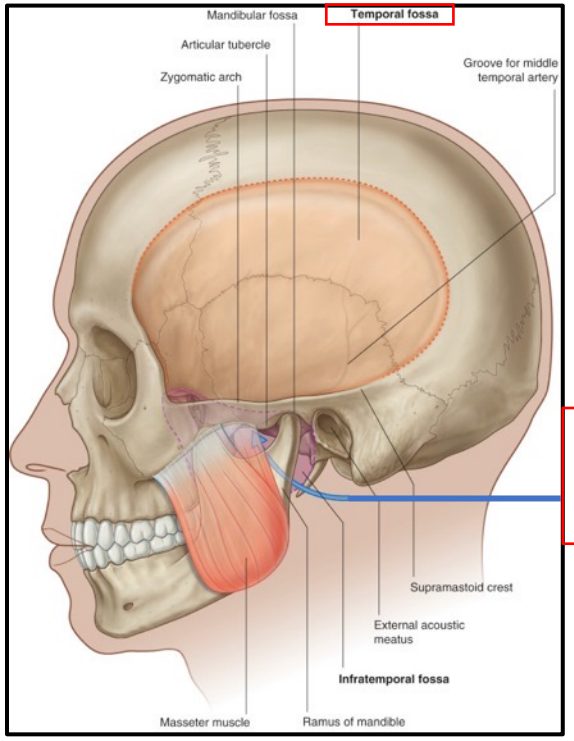




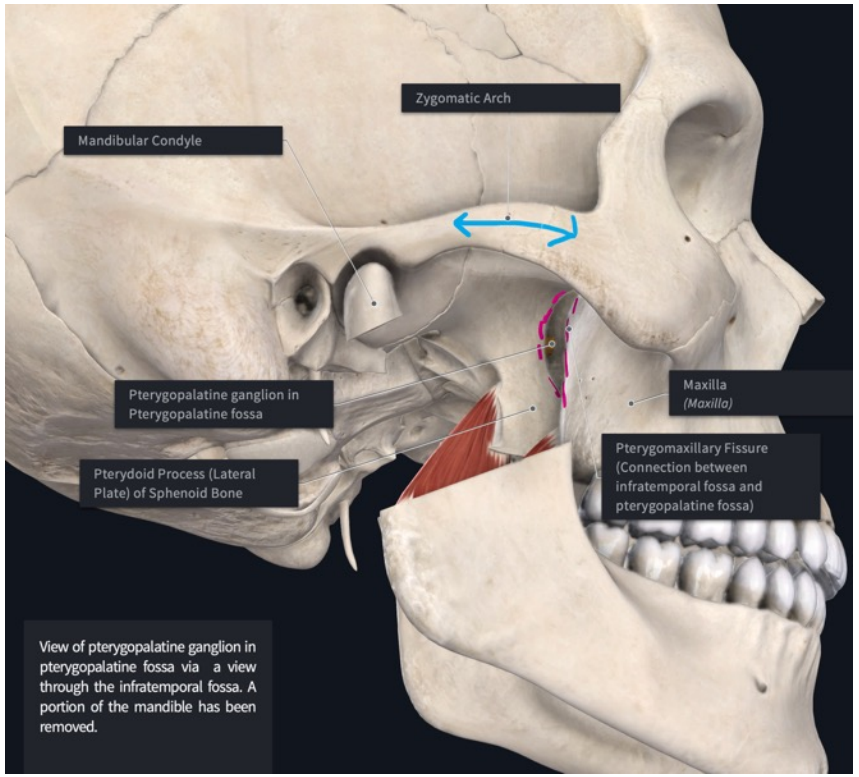
Infratemporal Fossa & Pterygopalatine Fossa

The **temporal fossa** and **infratemporal fossa** are interconnected spaces on the lateral side of the head.

- The **temporal fossa** is a fan-shaped region of the lateral skull superior to the zygomatic arch.
- The **temporal fossa** communicates with the **infratemporal fossa** by the space medial to the zygomatic arch. It is a wedge-shaped region medial to the ramus of the mandible.
    - To help you understand the location, listed below are the boundaries. However, you don't need to memorize the boundaries.
        - Lateral border: ramus of the mandible
        - Medial border: lateral pterygoid plate of the sphenoid
        - Anterior border: posterior surface of the maxilla
    - Posterior border: mastoid and styloid processes of temporal bone



Infratemporal Fossa Shown in Purple



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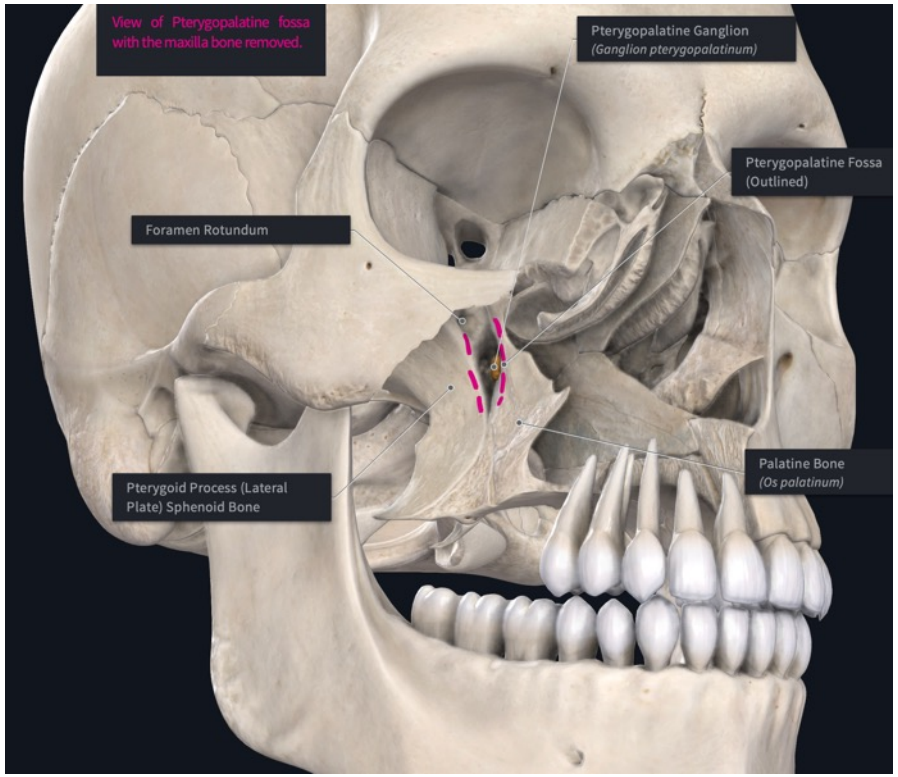

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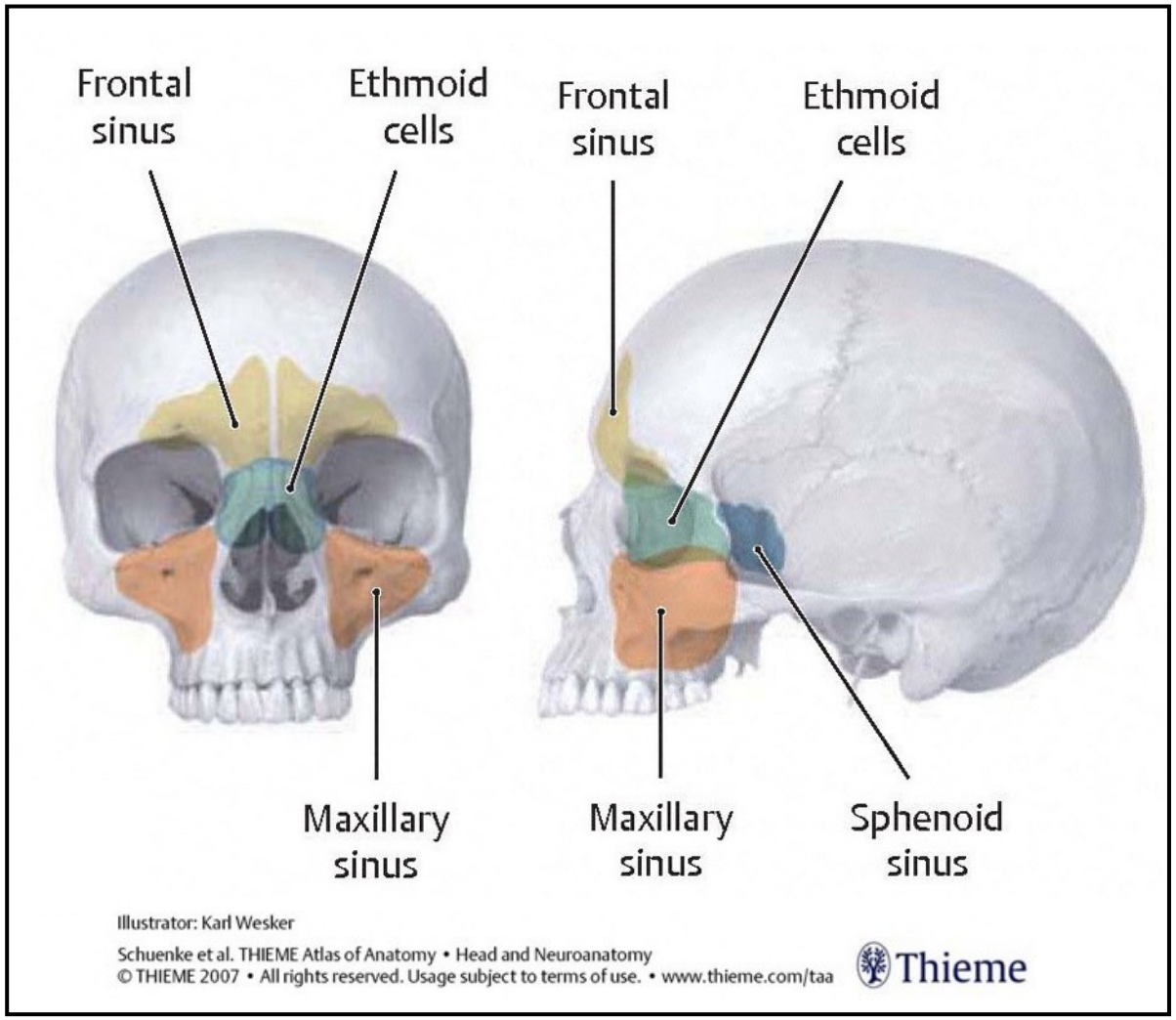
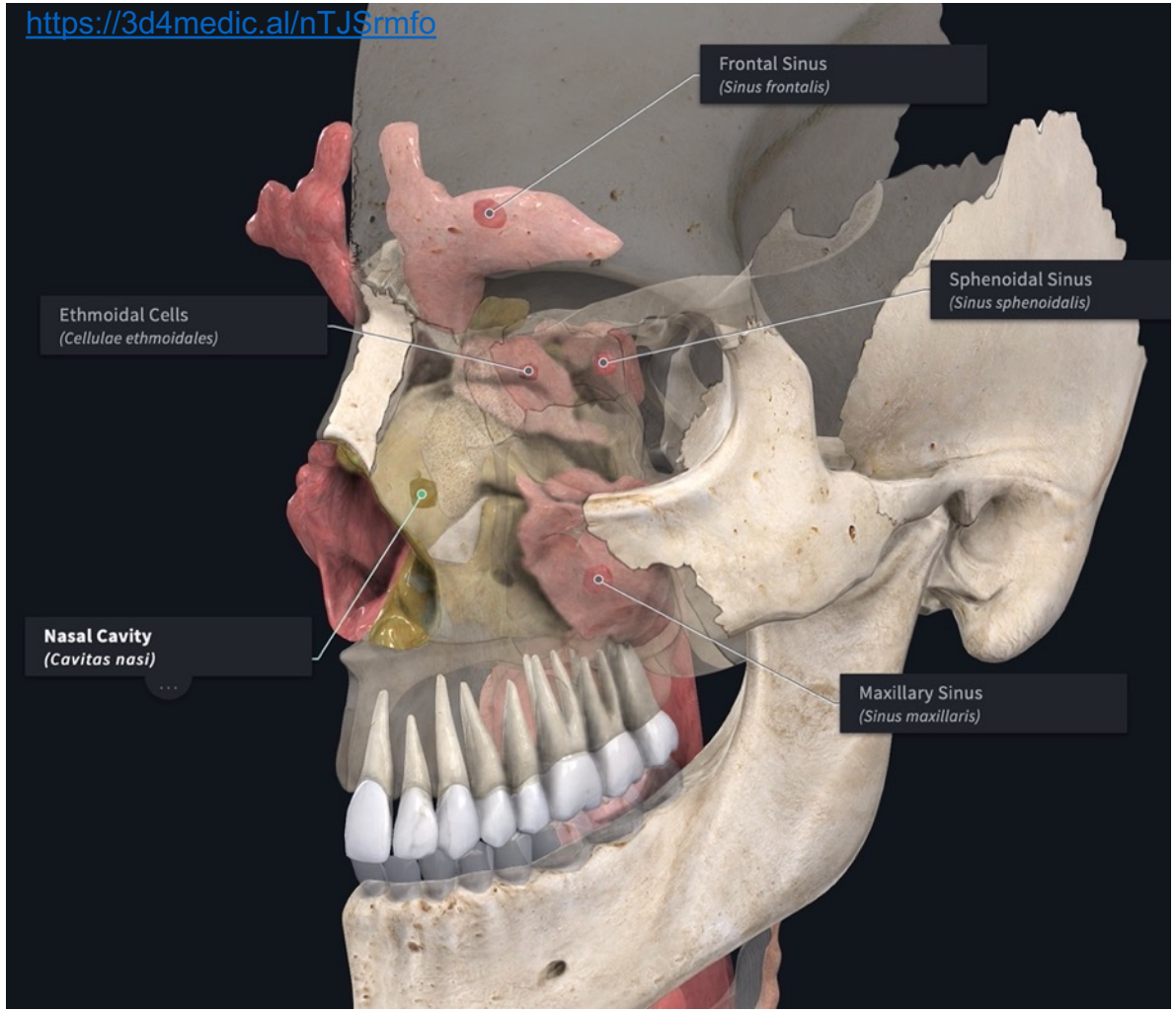
Paranasal Sinuses

As the **viscerocranium** expands (through cartilage and sutural growth), outgrowths of the lateral nasal walls protrude into the adjacent bones. These, mucous membrane lined, air-filled cavities within bones are the **paranasal sinuses**. **Paranasal sinuses** are named for the bones in which they are located: **frontal**, **ethmoidal**, **maxillary** and **sphenoidal**.

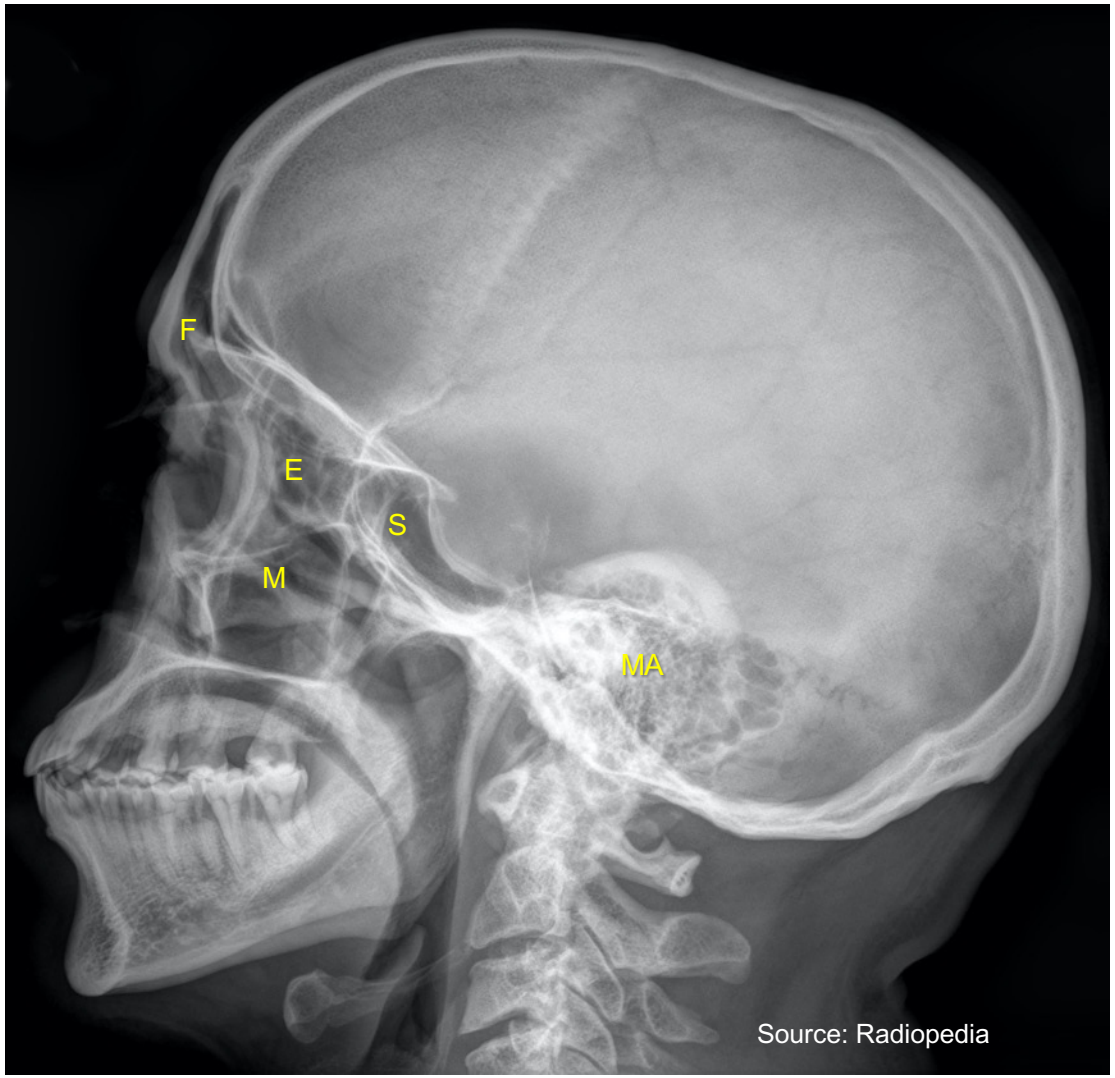


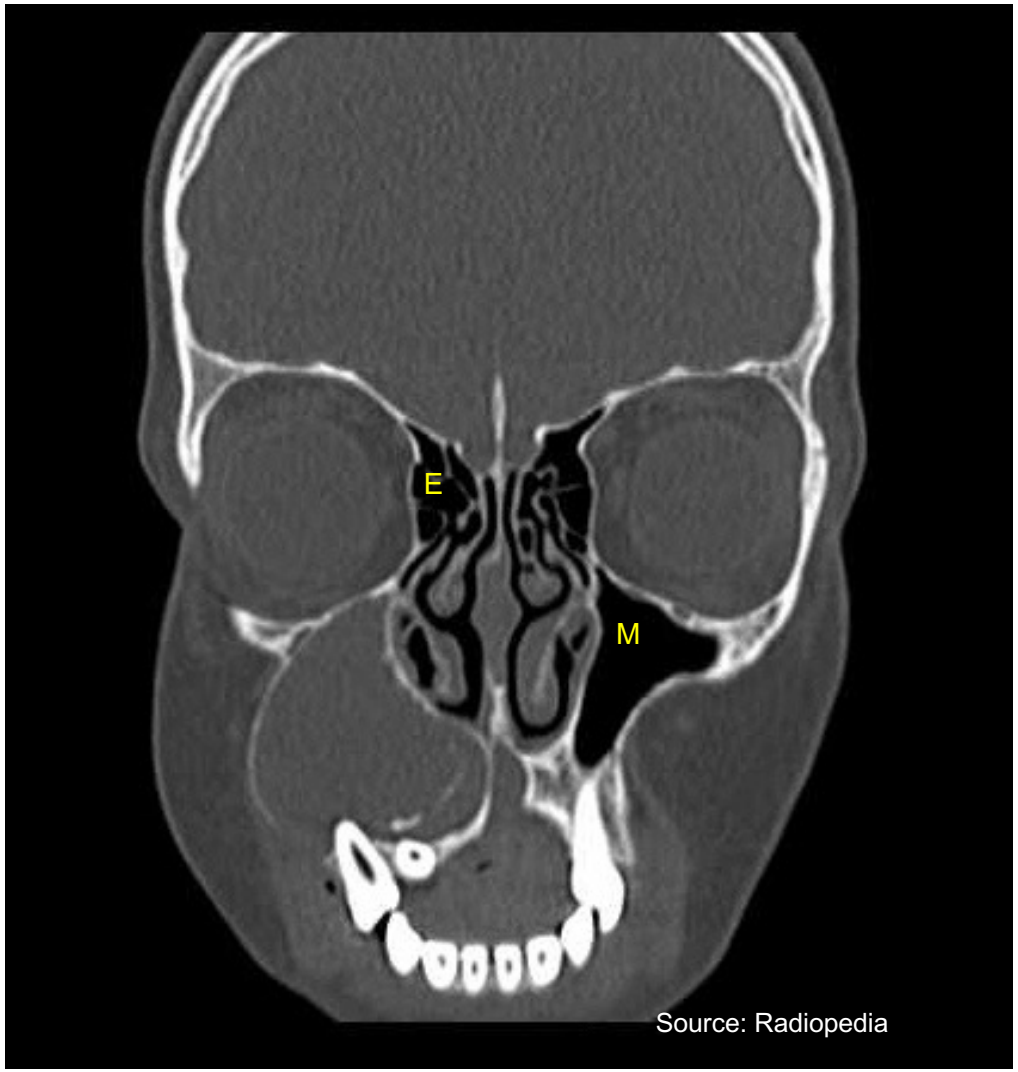


Nasal Cavity Highlighted in Green

Paranasal Sinus Imaging

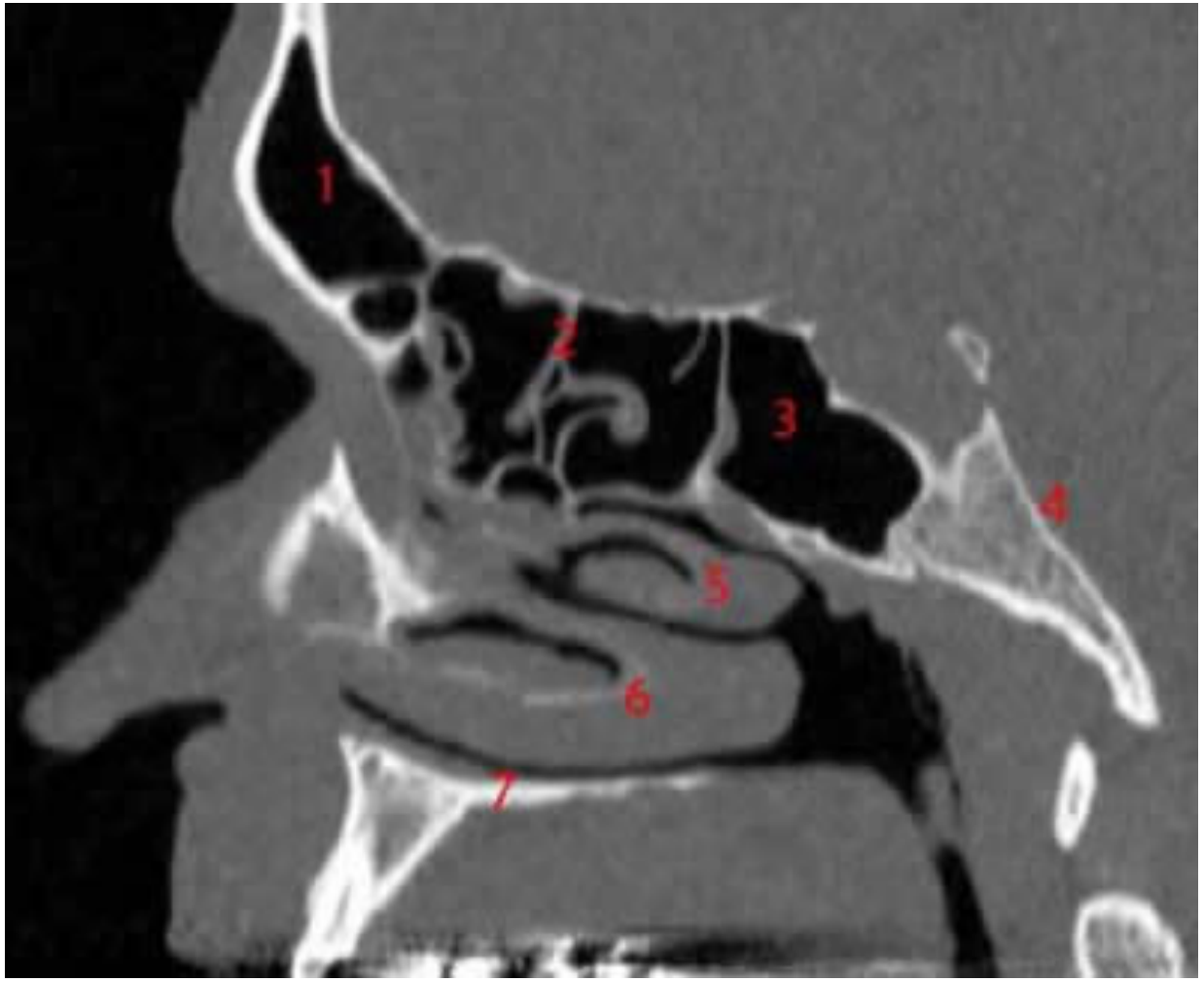
Different types of radiographic imaging show the **paranasal sinuses** (below: X-ray, left; CT, right). **Paranasal sinuses** are named for the bones in which they are located: **frontal** (F), **maxillary** (M), **sphenoidal** (S), and **ethmoidal air cells** (E). Note also, the *mastoid air cells (MA)*, which "pneumatize" the mastoid process of the temporal bone.





Paranasal Sinus Imaging (Sagittal Section)

Sagittal CT Scan



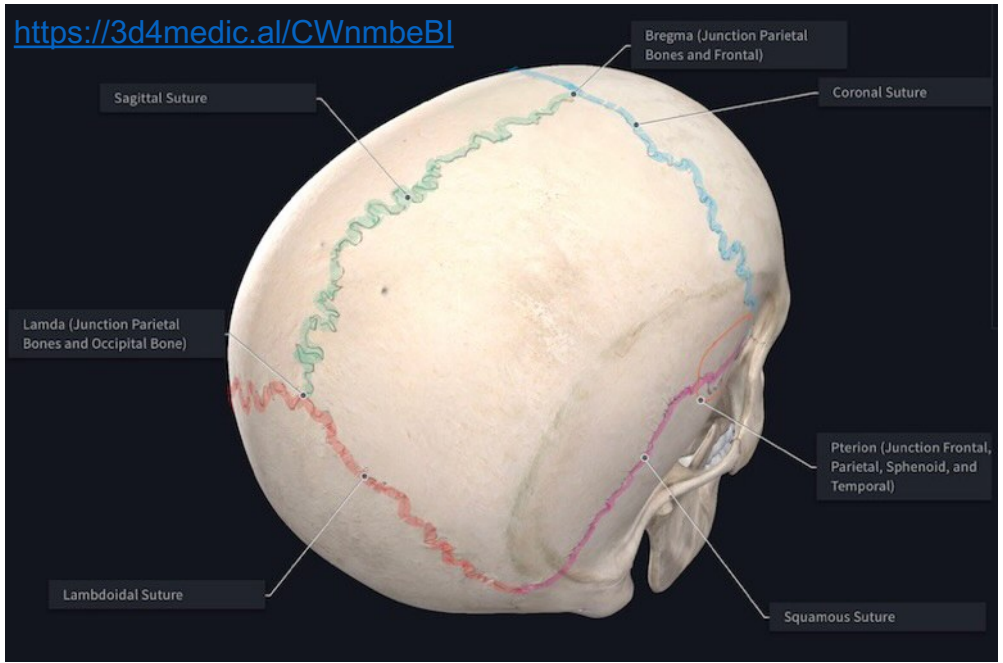
1 = Frontal Sinus
2 = Ethmoid Sinuses
3 = Sphenoid Sinuses
4 = Clivus
5 = Middle Concha (Turbinate)
6 = Inferior Concha (Turbinate)
7 = Hard Palate

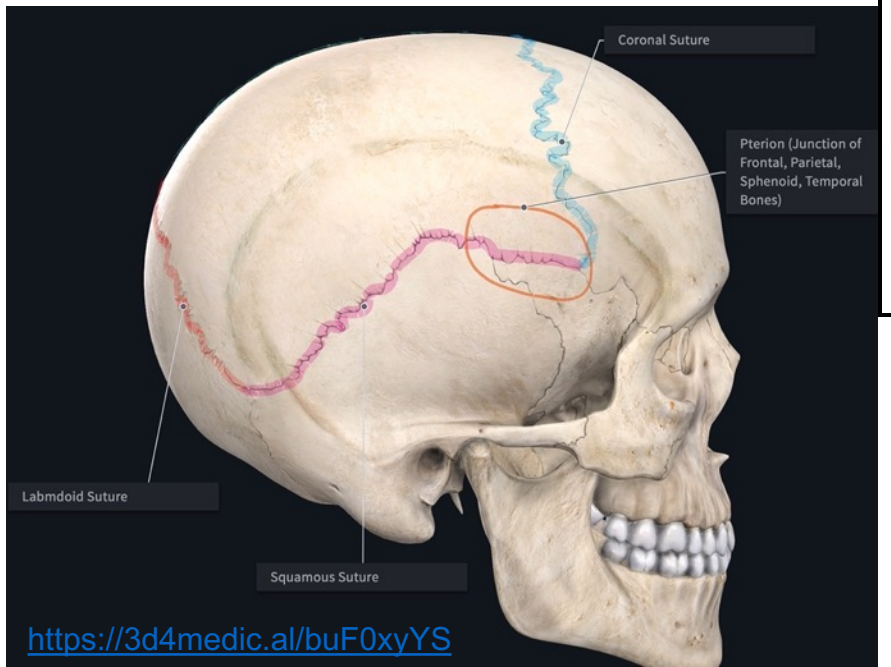
Skull Sutures

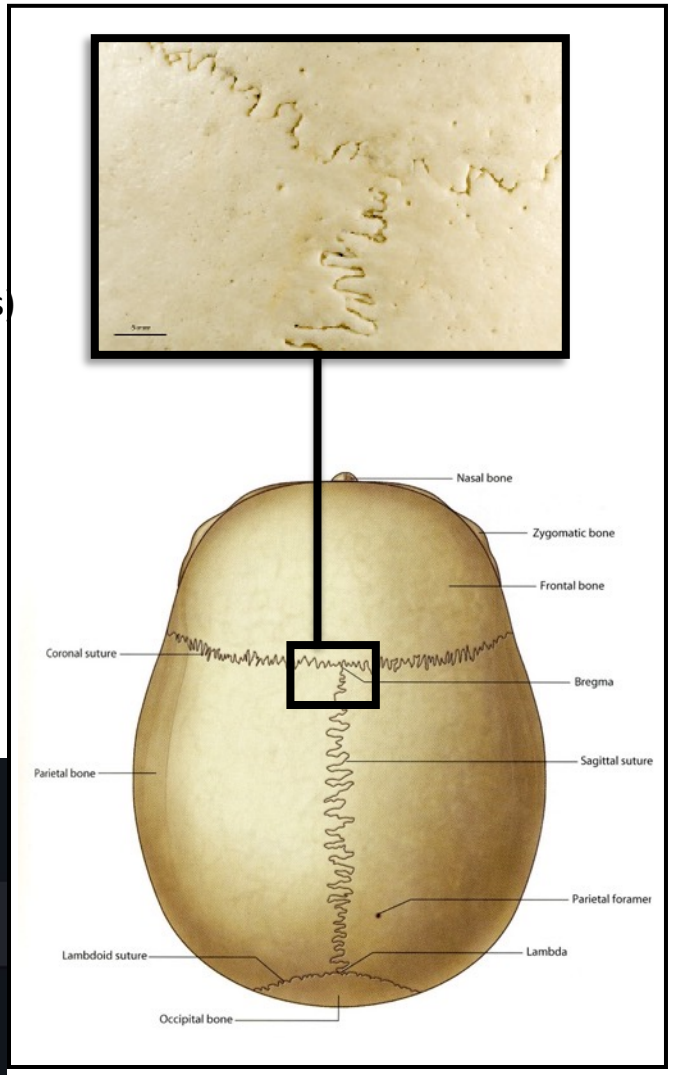
In a fully-grown skull, the bones of the neurocranium are joined at joints called **sutures**.

- Sutures are interlocking fibrous joints that allow for limited movement.
- The articulating surfaces of each bone at a suture consists of jagged edges, which interdigitate to lock the bones together. In addition, the interlocking bones are reinforced by dense, fibrous connective tissue.
- The major (largest) sutures are listed below.
  - **Sagittal** (between the parietal bones)
  - **Squamous** (between parietal and temporal bones)
  - **Coronal** (between frontal bone and parietal bones)
  - **Lambdoid** (between occipital and parietal bones)
- The following list includes named suture junctions.
  - **Lambda**
  - **Bregma**
  - **Pterion.**

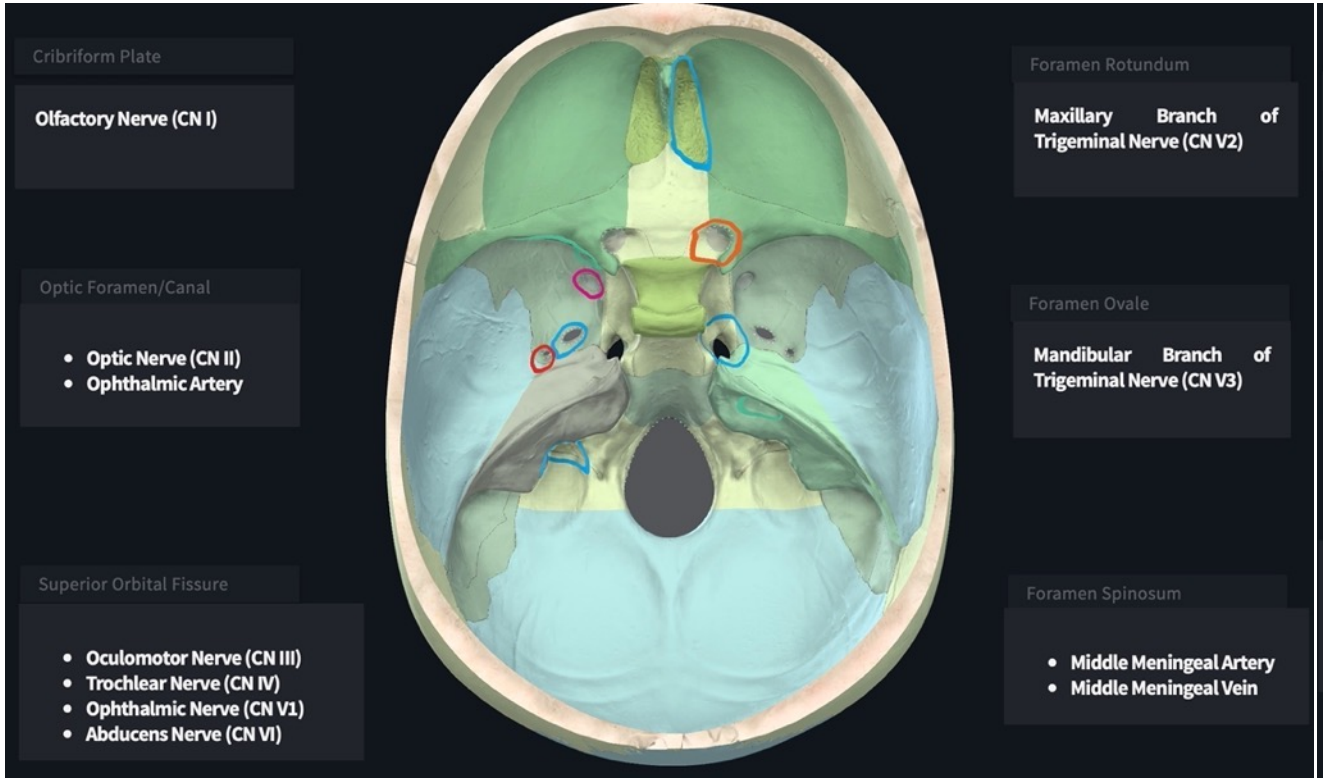
CLNICAL ANATOMY: The clinical consequences of a skull fracture in the pterion region can be very serious. The bone in this area is particularly thin and overlies the anterior division of the middle meningeal artery, which can be torn by a skull fracture in this area, resulting in an extradural hematoma. This will also be covered in Lab 1.







Foramen Review: (Click the links to review the skull foramina on CA.)



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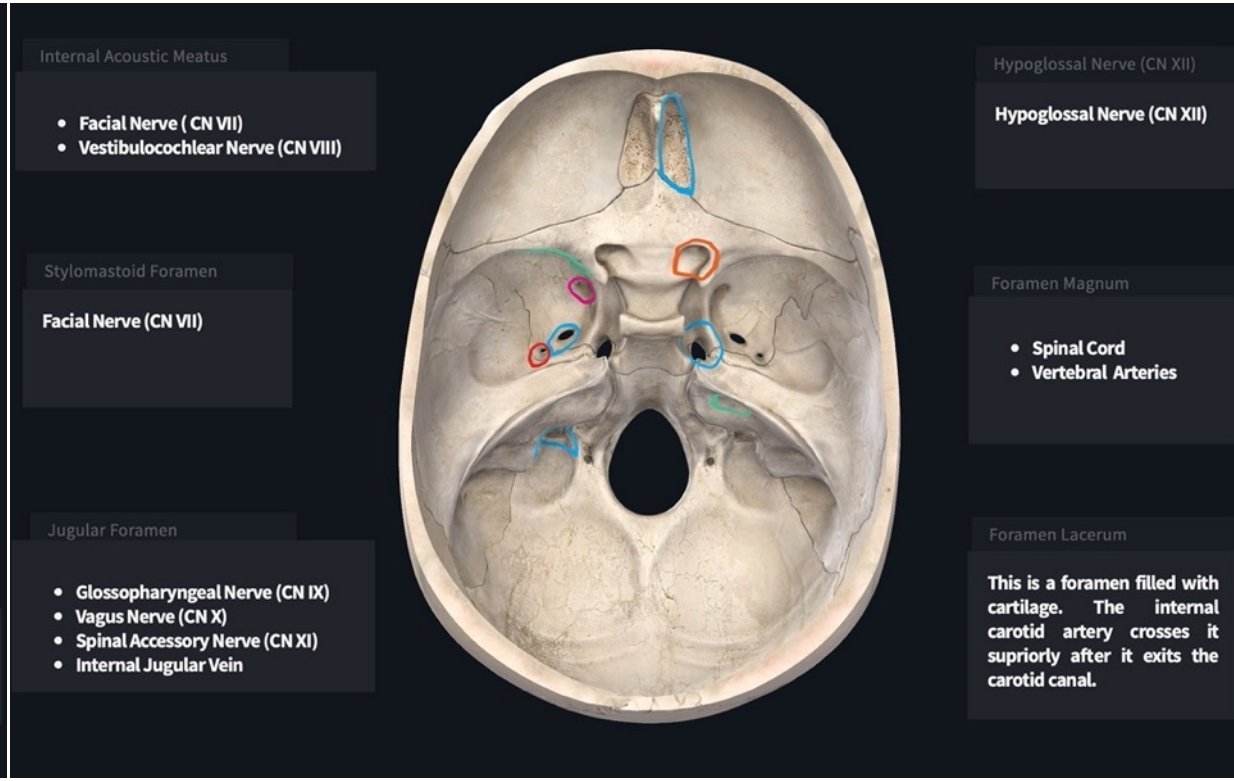

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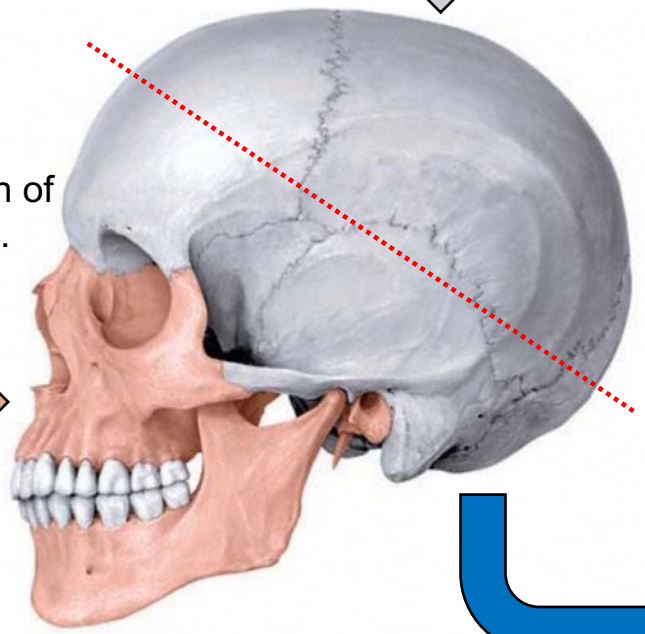
Skull Subdivisions

The skull bones (cranium) can be organized into two groups.

2. The **neurocranium** (gray) consists of bones that form the walls of the cranial cavity (aka: cranial vault), which is houses the brain.

1. The **viscerocranium** (orange) consists of skull bones that form the skeleton of the face and mandible (jaw).



The dome-shaped roof of the **neurocranium** is called the **calvaria.**

The floor of the **neurocranium** is called the cranial base (*basicranium*).

Skull Subdivisions: Viscerocranium

The **viscerocranium** consists of the following bones.

- **Ethmoid bone**
- **Lacrimal bone**
- **Nasal bone**
- **Vomer**
- **Inferior nasal concha**
- **Maxilla**
- **Mandible**
- **Zygomatic bone**
- **Palatine bone**

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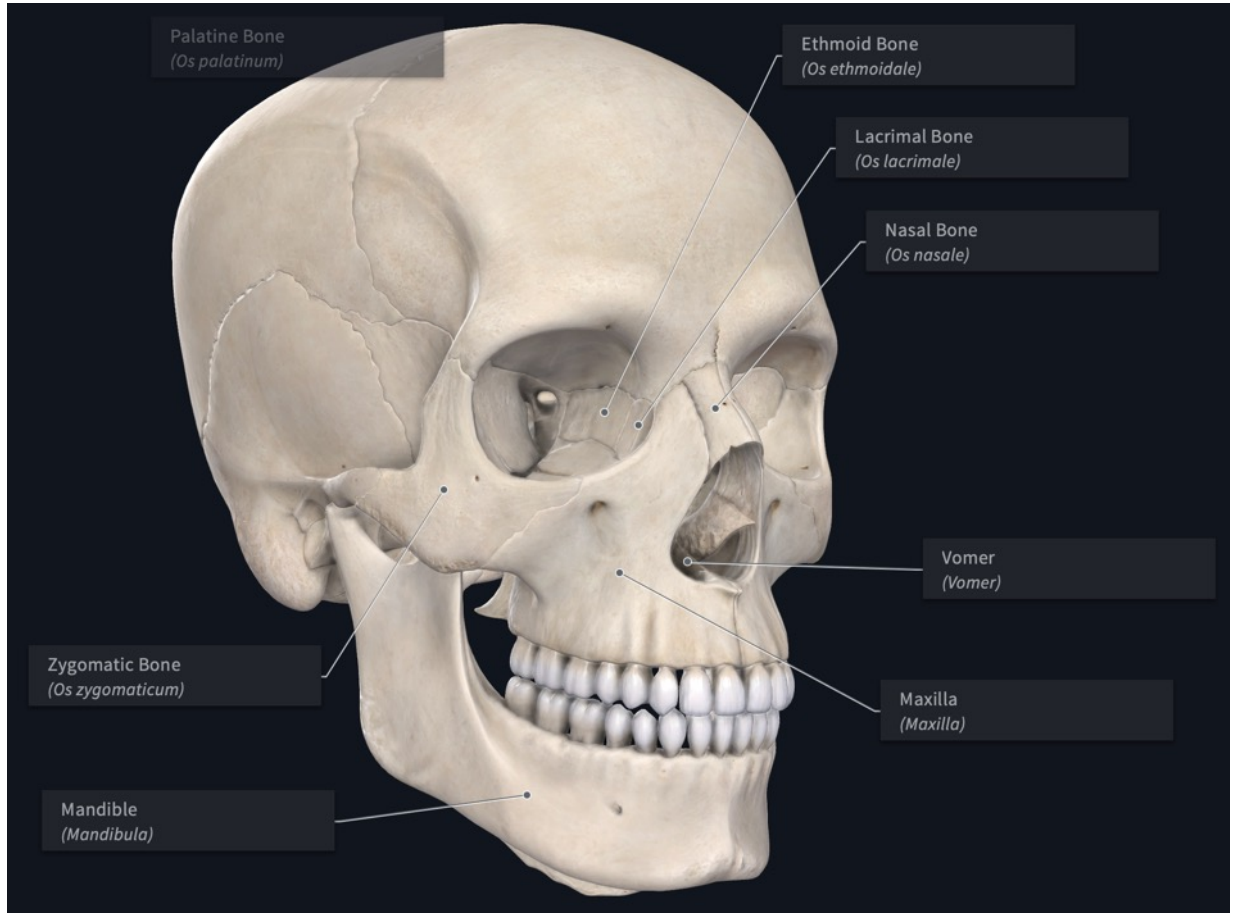
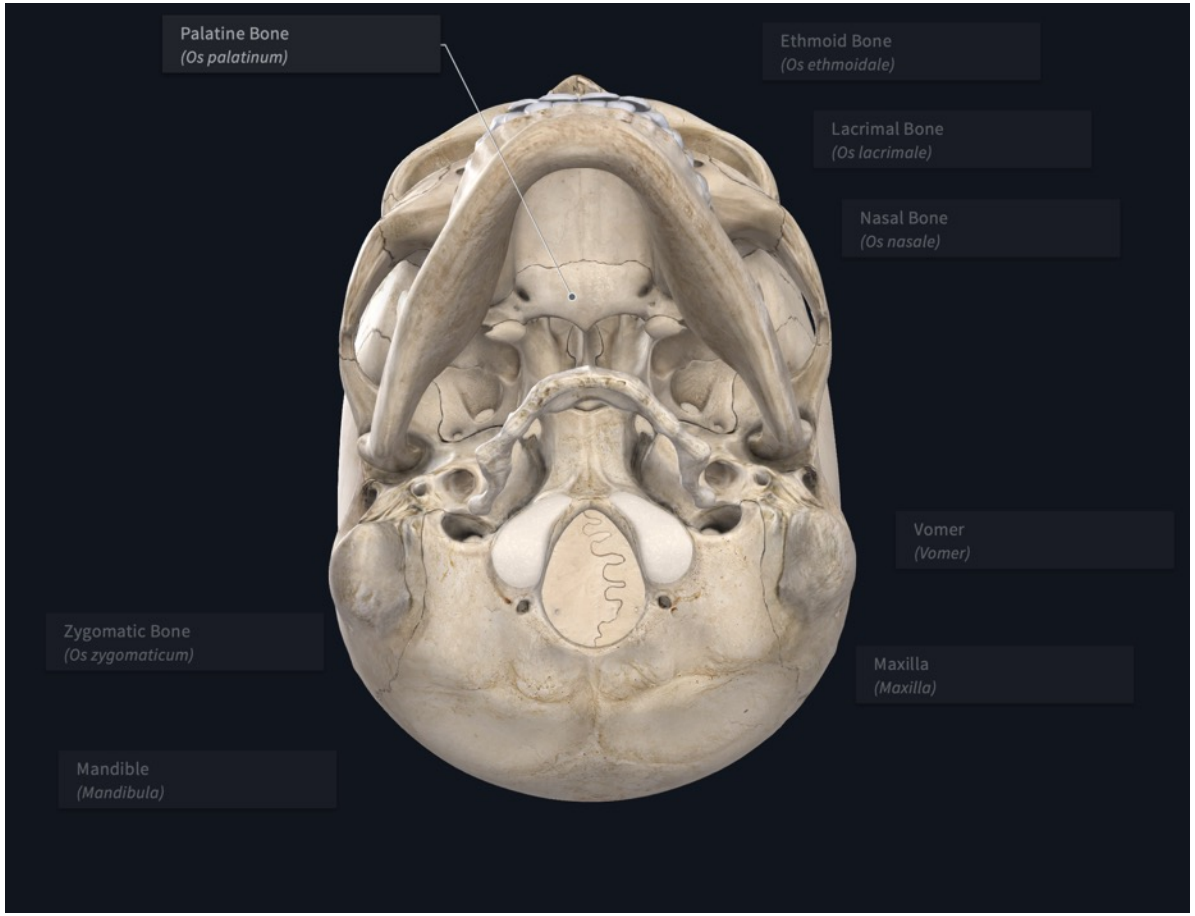




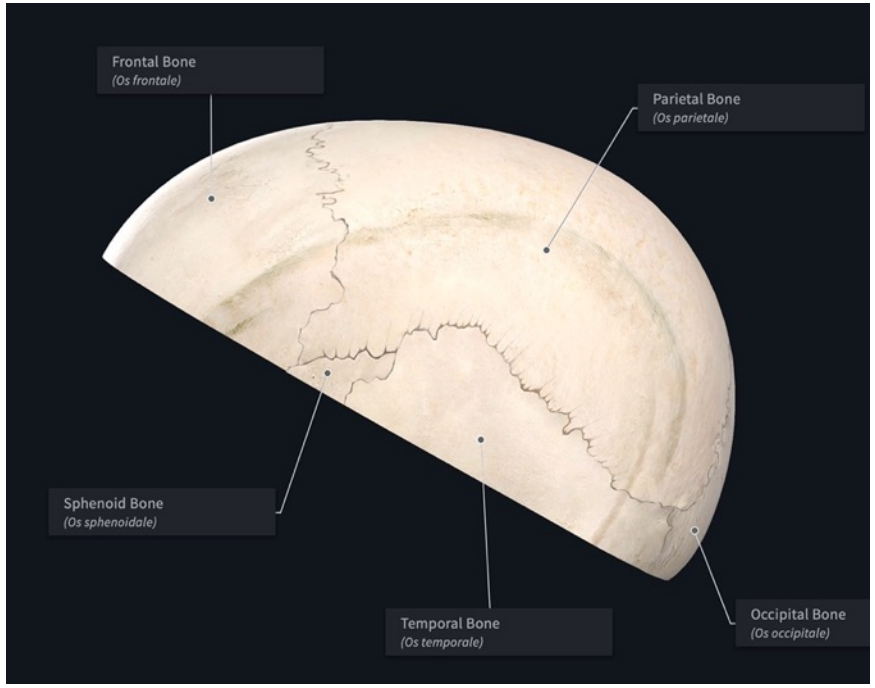
Skull Subdivisions: Neurocranium

The **calvaria** is the dome-shaped roof of the **neurocranium.** It is composed of the following bones.

- **Frontal**
- **Parietal**
- **Sphenoid**
- **Temporal**
- **Occipital**

The **cranial base** (basicranium) is composed of the following bones.

- Three *unpaired* bones:
  - **Ethmoid**
  - **Sphenoid**
  - **Occipital**
- Two *paired* bones that forming the lateral aspects of the cranial base.
  - **Frontal bones**
  - **Temporal bones**



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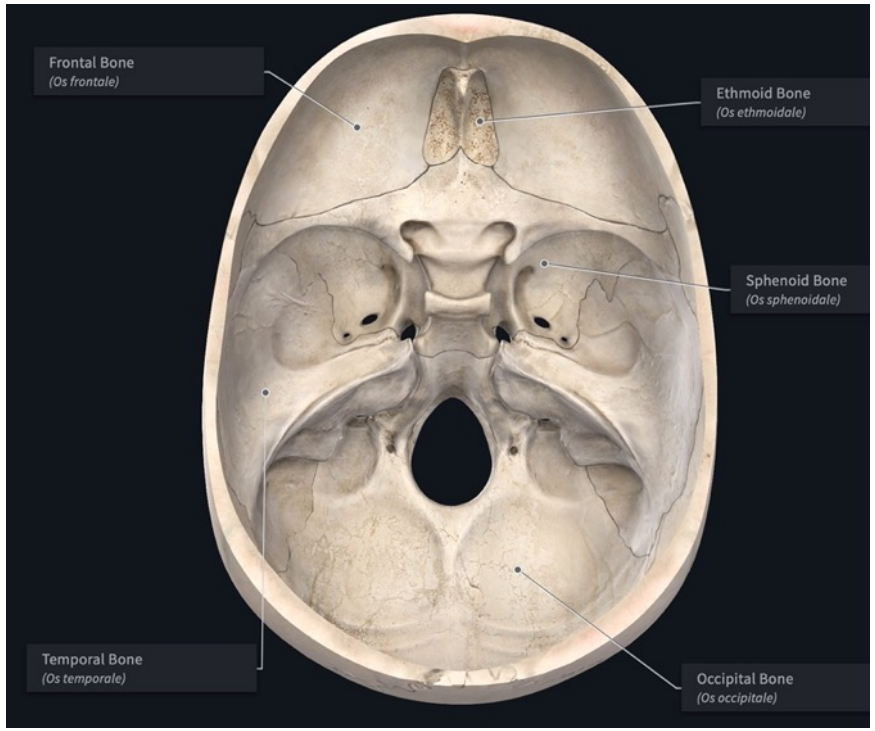

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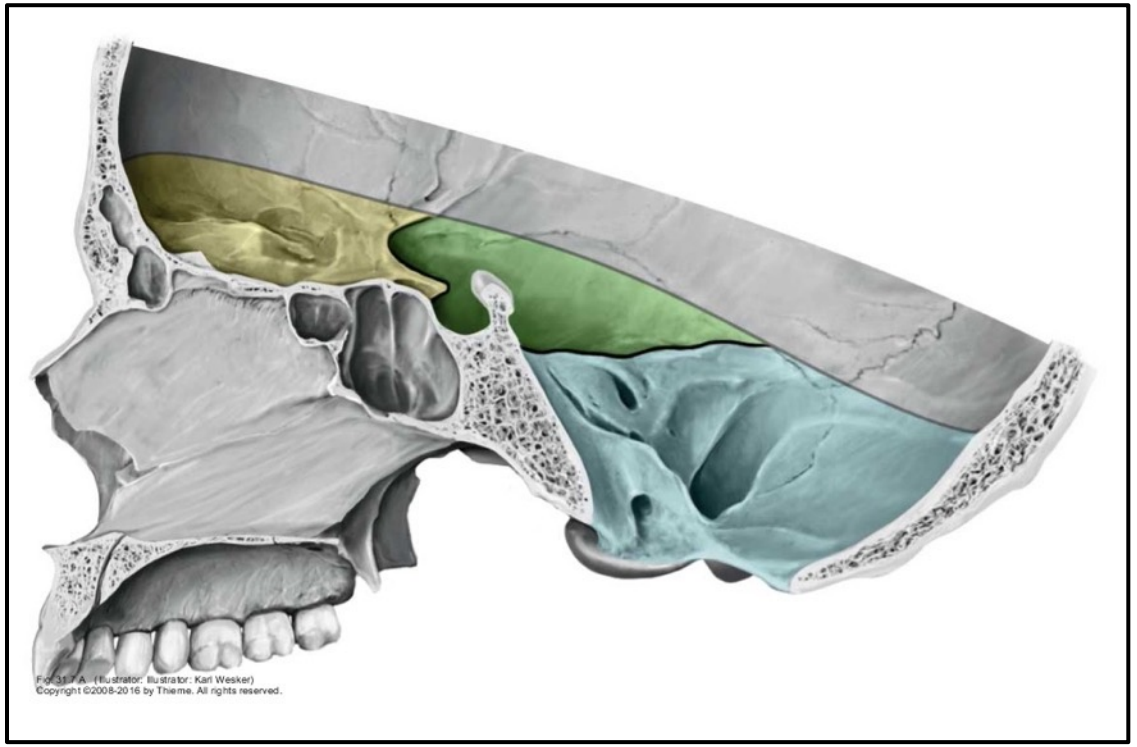
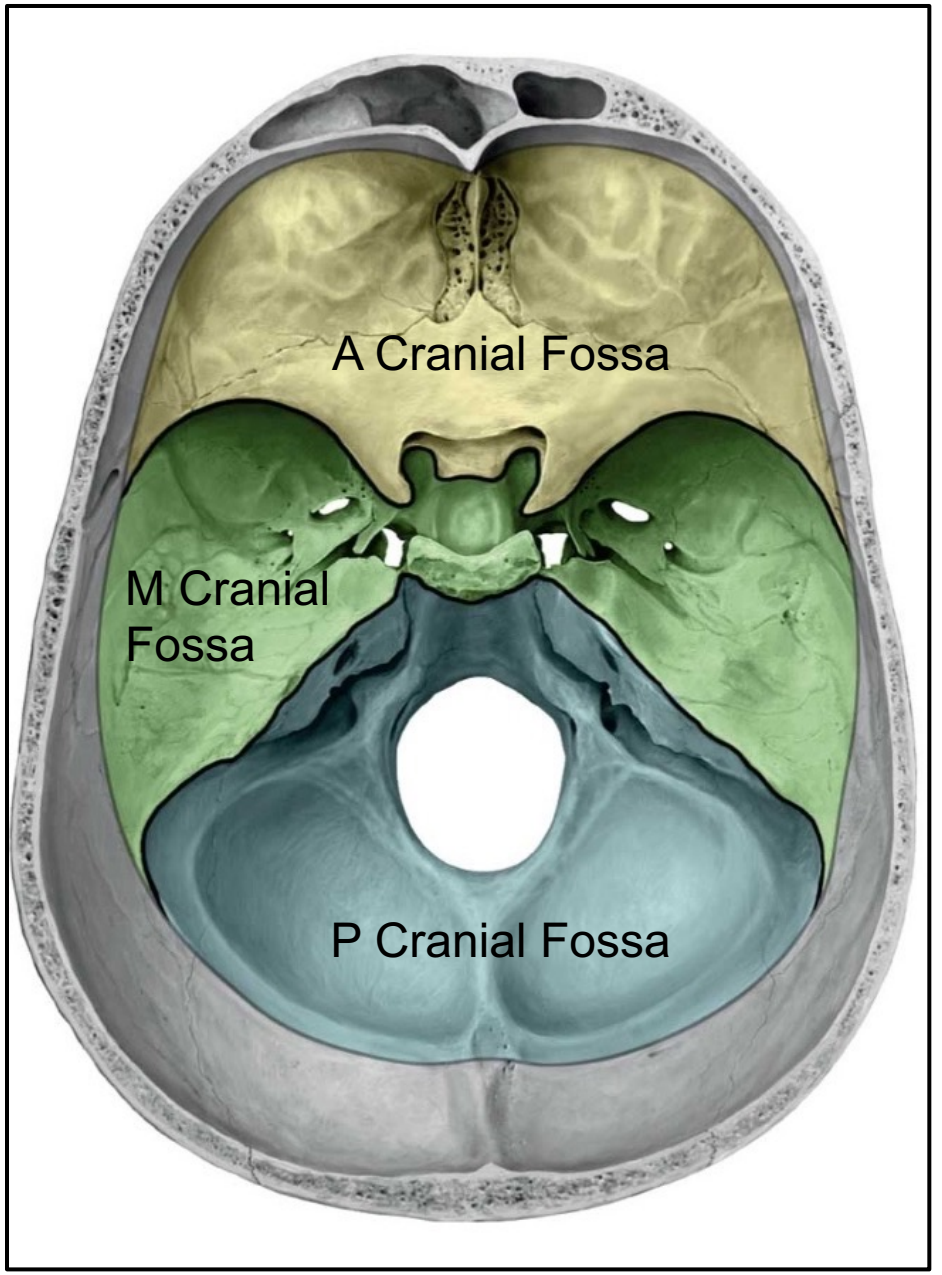
Cranial Base: Cranial Fossae

The floor of the neurocranium (basicranium) consists of 3 depressions known as cranial fossa. Each of these depressions contains a different part of the brain.

- **Anterior Cranial Fossa** = Yellow (Ethmoid, Frontal, and Sphenoid Bones)
    - Contents = Frontal lobe of the cerebrum, Olfactory bulb, Olfactory tracts
- **Middle Cranial Fossa** = Green (Sphenoid and Temporal Bones)
    - Contents = Central portion contains the pituitary gland
    - Contents = Lateral portions contain the temporal lobes of the cerebrum
- **Posterior Cranial Fossa** = Blue (Occipital and Temporal Bones)
    - Contents = Brainstem and Cerebellum



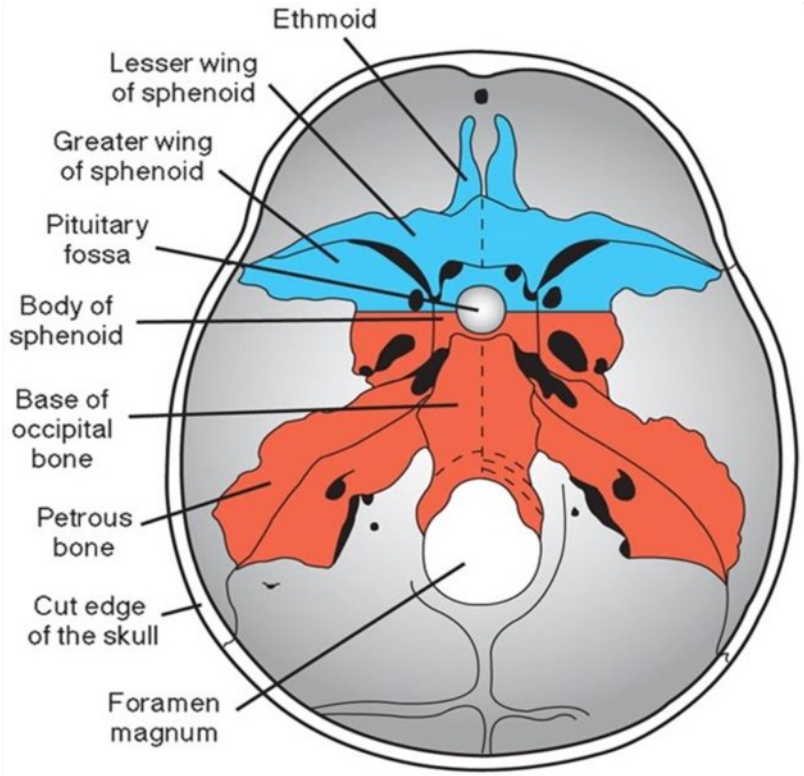


Skull Development: Intramembranous vs Endochondral Ossification

The bone tissue of the skull is produced by both **endochondral** and **intramembranous ossification**.

- Endochondral Ossification: (Chondrocranium)
  - Most of the cranial base (This includes the ethmoid and portions of the frontal, sphenoid, temporal and occipital bones). (Red and Blue Areas of Figure)

- Intramembranous Ossification: (Membranous Cranium)
  - Most of the bones of the face (viscerocranium) are formed by intramembranous ossification.
  - The bones of the calvaria are formed by intramembranous ossification. (This includes the parietal bones and the flat portions of frontal, sphenoid, temporal bones, and occipital bone) (Gray Areas of Figure)



Red and Blue = Endochondral Ossification
Gray = Intramembranous ossification

Cranial Base (Superior to Inferior View)

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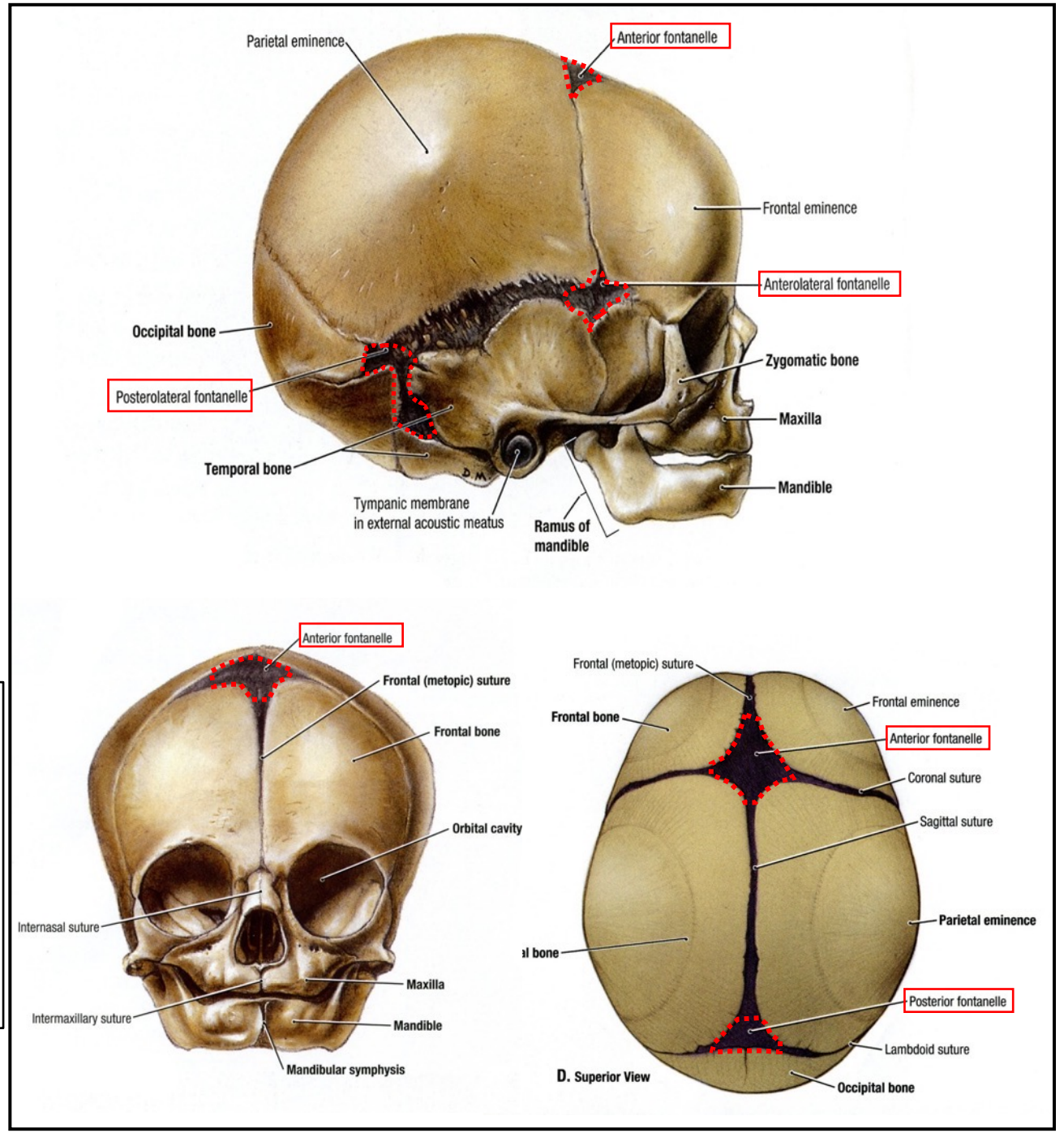
Calvaria (Side View)

Intramembranous Ossification: Fontanelles

- The flat bones of the skull begin as islands of bone that enlarge radially by intramembranous ossification. As a result of this radial growth, neighboring cells become separated by **sutures,** which are narrow seams of fibrous connective tissue.
  - The neonatal skull contains **fontanelles,** which are fibrous connective tissue filled gaps where sutures intersect.
    - Fontanelles allow the skull to deform during passage through the birth canal and allow the cranium to enlarge during infancy and childhood.
    - At birth, the skull contains six fontanelles that are located at each corner of the parietal bones.
      - **Anterior**
      - **Posterior**
      - **Anterolateral (sphenoid)** (1 on each side of skull)
      - **Posterolateral** (**mastoid**) (1 on each side of skull)

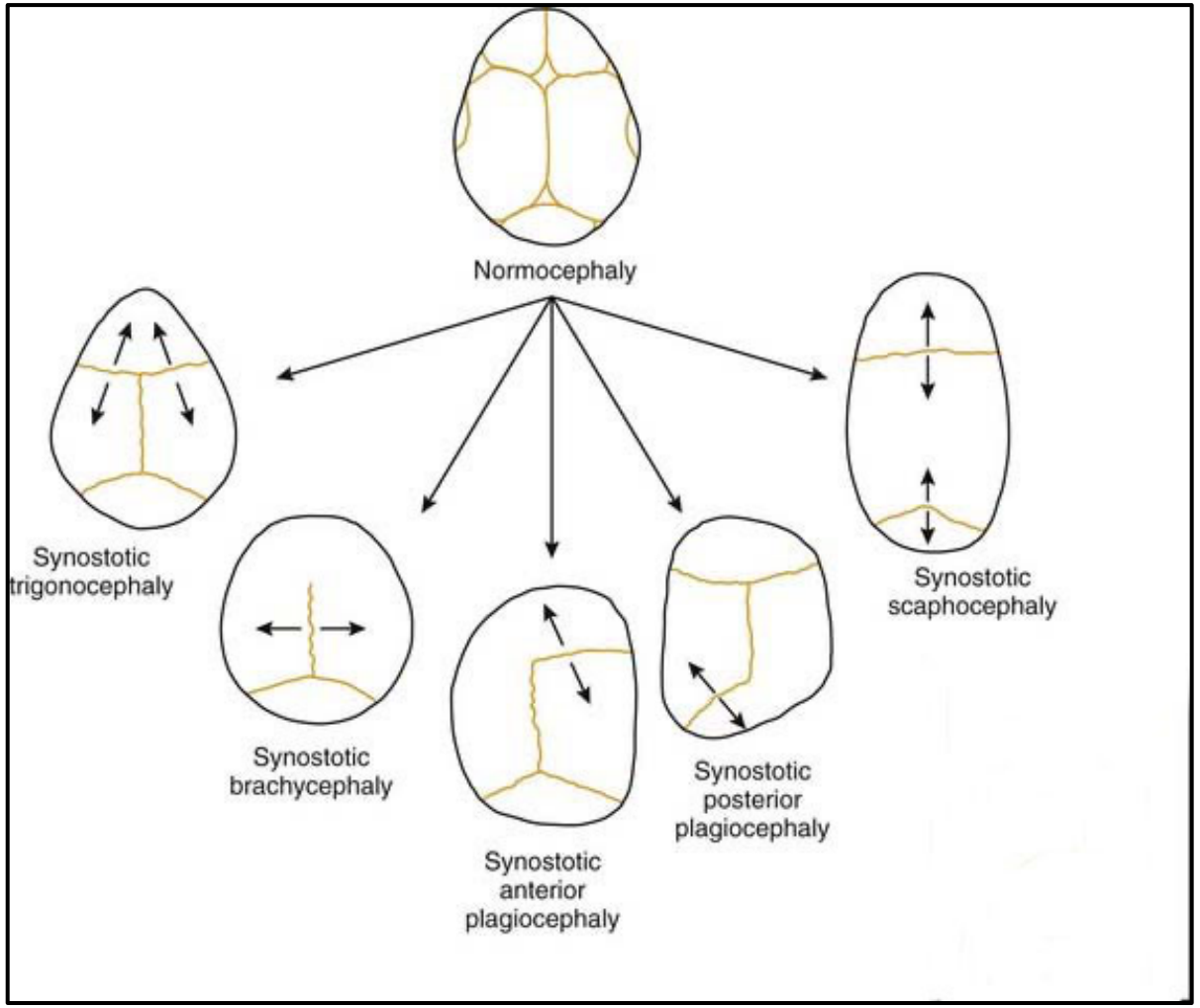
CLINICAL ANATOMY: The anterior fontanelle is the largest and most important for clinical evaluation. The average size of the anterior fontanelle is 2.1 cm, and is the last to close. The median time of closure for the anterior fontanel is 13.8 months. The most common causes of a large anterior fontanelle or delayed fontanelle closure are achondroplasia, hypothyroidism, Down syndrome, increased intracranial pressure, and rickets. A bulging anterior fontanel can be a result of increased intracranial pressure or intracranial and extracranial tumors. A sunken fontanelle can be a sign of dehydration.



Intramembranous Ossification: Craniosynostosis

Premature suture fusion is called **craniosynostosis,** which is an anomaly of development that results in a deformation of calvarial shape. The resulting form of the calvaria depends on which **suture** is involved and reflects the need for patent (unfused) **sutures** to compensate for the loss of growth potential in specific planes.

- Premature fusion of the sagittal suture restricts transverse growth of the skull, which results in increased anteroposterior skull length to accommodate brain growth. This results in the formation of a long, narrow, wedge-shaped calvaria called **scaphocephaly**.
- Premature fusion of bilateral coronal sutures restricts growth in an anterior direction, which results in increased growth laterally to accommodate brain growth. This results in a wider and shorter than normal skull called **brachycephaly**. Compensatory vertical growth of the skull may also occur.
- Premature closure of only one side of the lamdoidal or coronal suture results in a twisted asymmetry called **plagiocephaly**.
- Premature closure of both the lamdoidal and coronal sutures results in a high, tower like cranium called **oxycephaly** (aka acrocephaly).



Endochondral Ossification

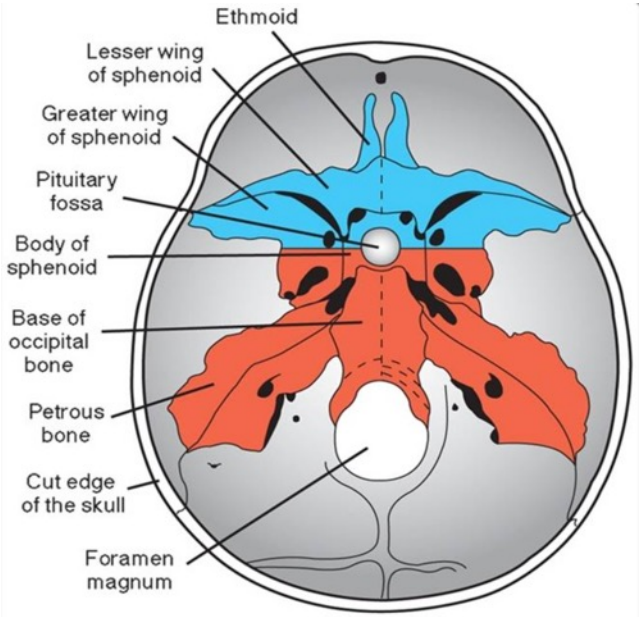
- The skull base (cartilaginous neurocranium) initially consists of a number of separate cartilages, which fuse and ossify by endochondral ossification.

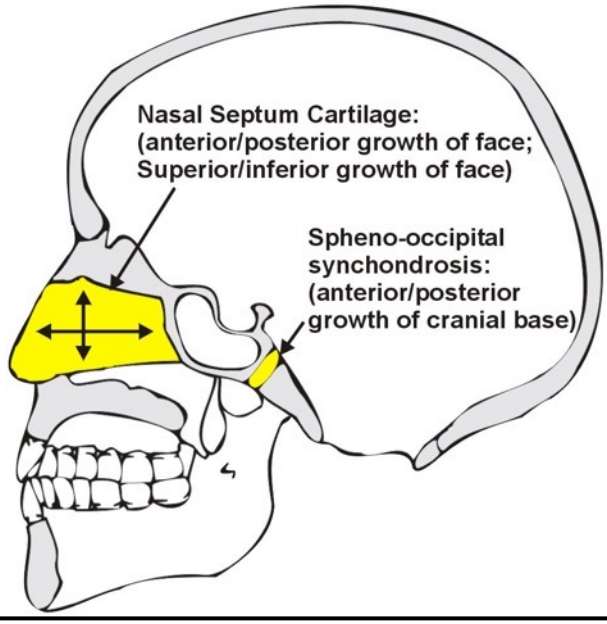
- For the purpose of cranial growth, cartilage persists in two important locations in the skull.
  - The **spheno-occipital synchondrosis,** which is located at the base of the neurocranium (between the sphenoid bone and the occipital bone) is the equivalent of an epiphyseal plate of a long bone. In fact, histologically, it is the equivalent of two adjacent growth plates oriented in opposite directions. The spheno-occipital synchondrosis represents a major site of anterior/posterior-directed **growth of the neurocranium**.

  - The midline **nasal septum** represents a major site of anterior-posterior and superior-inferior **growth of the facial skeleton**. By virtue of its ability to grow both *interstitially* and *appositionally*, this cartilage is capable of undergoing rapid expansion during growth.

Growth at the spheno-occipital synchondrosis and the nasal septum pushes the skull bones apart, which induces bone deposition at the skull's **sutures**. These growth cartilages of the skull are subject to the same regulatory mechanisms as the epiphyseal plates of the long bones. The spheno-occipital synchondrosis and the posterior aspect of the nasal septum will eventually disappear (ossify) when growth ceases. However, the anterior most portion of the cartilaginous nasal septum, where it contributes to the flexible exterior skeleton of the nose, will remain cartilaginous.

Red and Blue = Endochondral Ossification
Gray = Intramembranous ossification





Achondroplasia and Skull Growth

Achondroplasia affects the growth cartilages of the skull in addition to affecting the growth cartilages of long bone. In these individuals, the following features can be recognized.

- The nose is small due to reduced growth of nasal septum cartilage.
- The calvaria is expanded superiorly and anteriorly due to reduced growth of both the nasal septum cartilage and the spheno-occipital synchondrosis, respectively.